

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. 23

SEPTEMBER, 1934

NO. 3

ACNE VULGARIS AND THE ROENTGEN RAYS

A STATISTICAL REPORT¹

By GEORGE M. MACKEE, M.D., and FRANKLIN I. BALL, M.D., *New York City*

From the Department of Dermatology and Syphilology, New York Post-graduate Medical School and Hospital, Columbia University

MEDICAL literature contains many articles on the subject of the x-ray treatment of acne vulgaris, but comparatively few of them deal with statistics based on a large amount of material that has been under observation for many months or years. Statistics can be misleading, but when properly compiled they are invaluable for the control of impressions. Our knowledge of results obtained with the roentgen rays in dermatology is based largely on impressions. For an accurate therapeutic appraisal, statistics from many workers are required. After a sufficiently large number of such statistical reports have been published, they can be compiled and analyzed in an attempt to formulate an accurate evaluation.

Years ago the senior writer believed that with the x-ray treatment of acne vulgaris, with the technic universally employed in this country, permanent cures amounted to 85 or 90 per cent; also, that not more than 20 per cent were cured in a reasonable length of time with methods other than x-rays.

Later, this impression was found to be erroneous, as shown by the following statistics based on treatment in private practice, which were published in 1927:²

Total number of acne cases treated with x-rays.....	244
Number of patients cured within four months.....	147 (60%)
Number of patients requiring more than four months.....	84 (35%)
Number of failures.....	13 (5%)
Number of patients who had one recurrence.....	37 (10%)
Number of patients who had a second recurrence.....	2 (0.8%)

In this group 60 per cent of the patients were clinically cured with one course of treatment; that is, in four months or less. However, recurrences amounted to approximately 11 per cent. The total number of permanent cures, with one course of treatment, is, therefore, reduced to about 50 per cent.

American dermatologists understand what is meant by conventional or routine x-ray treatment of acne vulgaris. For others we briefly outline such treatment: The dose is 75 roentgens (estimated with the condenser type of Victoreen ionization dosimeter with chamber in air) administered to each side of the face (back and chest when necessary) once weekly. The radiation is unfiltered. The kilovoltage ranges from 80 to 100, depending upon whether thermionic or mechanical rectification is used. The effective wave length is approximately 0.68 Ångstrom unit. The approximate millimeters of half value

¹ Accepted for publication, Aug. 2, 1934.

² MacKee, G. M., *X-rays and Radium in the Treatment of Diseases of the Skin*, second edition, Lea and Febiger, Philadelphia, 1927, p. 434.

layers in aluminum is 0.571. The maximum number of treatments is 16. Treatment is discontinued as soon as lesions cease to develop. Not infrequently only six, eight, or ten treatments are necessary. Irritating and stimulating topical remedies are interdicted. Attention is given to the general health, hygiene, diet, etc. Remedies by ingestion are given when necessary or advisable. All patients included in our x-ray statistics (in this article) were treated in this manner. At the beginning of treatment we carry out skin tests for toleration to x-rays. If toleration is low, the dose is reduced to about 37.5 roentgens. Also, during the course of treatment patients are tested each week for "impending erythema." This consists of noting increase of local vasomotor instability, with change of posture, pressure, heat, irritation, etc. "Impending erythema" calls for cessation of irradiation or reduction of the dose. It may be added that a change from routine treatment is seldom necessary.

In the statistics recorded above, the patients requiring more than four months were those who still had a few lesions and who required strong topical remedies and general medical attention to complete the cure after x-ray treatment was discontinued.

The subjoined statistics were compiled in 1927 also: they comprise patients who did not receive x-ray treatment and who were observed for long periods.

Total number of patients treated without x-rays.....	72
Number of patients cured within six months.....	16 (22%)
Number of patients cured in one or two years.....	29 (40%)
Number of failures.....	27 (38%)
Number of patients with one recurrence.....	8 (11%)
Number of patients with a second recurrence.....	1 (1.5%)

Of these patients, 22 per cent were clinically cured in six months, 40 per cent in one or two years. Recurrences amounted

to 12 per cent. The final result is 50 per cent permanent cures in two years or less as compared with a like number of permanent cures with x-ray treatment in four months or less. It is possible that some of these one- and two-year cases might have been cured spontaneously in that length of time.

In this short report no attempt is made to exhaustively review the literature. The subjoined statistical reports, with which we are familiar, are from the medical literature of this country. Howard Fox³ reported 191 cases of acne treated with x-rays, 111 of which were cured, 47 practically cured, 27 improved but did not continue treatment, 2 failures, and 4 recurrences. Maurice Brown⁴ reported 36 cases, with 20 cures, 16 very much improved, and 7 recurrences.

Michael's⁵ technic was about the same as ours. He also reviews the literature prior to 1928. In that year he published the following statistics: The total number of patients with known end-results was 191. Of these, 101 (53 per cent) were cured with one course of treatment; 23 (12 per cent) were greatly improved; 67 (35 per cent) of the cured cases relapsed. After a second course of treatment, final success was obtained in approximately 85 per cent of the cases. Hazen and Eichenlaub⁶ report on 175 cases. They used about 144 roentgens every second week. There were 7 failures and 39 recurrences. With conventional technic, Crutchfield⁷ had 9 recurrences in a series of 96 patients, two-thirds of whom were cured with a second course of treatment. McCafferty and McCarthy⁸ in a series of 70 patients, report 10 per cent recurrences. Lord and

³ Fox, Howard, *Arch. Dermat. and Syph.*, January, 1924, 9, 13.

⁴ Brown, Maurice, *Arch. Dermat. and Syph.*, June, 1925, 11, 764.

⁵ Michael, J. C., *Arch. Dermat. and Syph.*, May, 1928, 17, 604.

⁶ Hazen, H. H., and Eichenlaub, F. J., *Arch. Dermat. and Syph.*, November, 1921, 4, 671.

⁷ Crutchfield, E. B., *Texas St. Jour. Med.*, November, 1923, 19, 395.

⁸ McCafferty, L. K., and McCarthy, C. L., *New York Med. Jour. and Record*, March, 1925, 121, 285.

Kemp⁹ published an excellent paper in 1931 in which they carefully analyzed the results obtained by the x-ray treatment of 406 acne patients, 247 of whom were followed for a sufficient length of time. Their technic was similar to ours. Approximately 75 per cent were cured or greatly improved; about 25 per cent had a recurrence, half of which were mild and half severe.

Recently, we have examined our office records covering a period of twenty years and the clinic records over a period of eight years. There were, in all, 5,376 cases of acne vulgaris, of which 606 patients received x-ray treatment and were followed through. Many more began x-ray treatment but failed to continue, and therefore, are not included in this study. Table I shows that only 13.7 per cent of the 5,376 patients received x-ray treatment. This is in accord with the gradually increasing belief that it is unnecessary and undesirable to treat all or most cases of acne with x-rays. There are definite reasons for this trend, a trend that is to the credit of modern dermatology and medicine. It is the result of a better general knowledge of medicine and of the general medical management of the disease, and a better appreciation of the advantages and limitations of the various therapeutic methods and combinations thereof. It is not due to untoward results nor to low x-ray efficacy. In this connection, however, it must be admitted that the x-ray treatment of acne is more hazardous than other methods, especially when the treatment is administered by those who lack skill or who are careless. To a constantly increasing degree dermatologists are using x-rays less as the path of least resistance, or as a source of remuneration. More of them try conventional dermatological therapy first, holding x-ray treatment in reserve. Better judgment is being used in selecting the best method for the individual case. So far as concerns patients, some prefer x-ray treatment

rather than topical remedies for various reasons, some neglect topical therapy and must be given x-ray treatment, while still others refuse x-ray treatment because of the fear of injury.

It will be noted that in the office records about 20 per cent of the patients received x-ray treatment, while in the clinic only about 7.5 per cent received such treatment. In explanation it can be stated that in the examination of 3,750 clinic records, it was found that although many more than the reported number began x-ray treatment, only 281 patients continued through to completion and these are the only ones used in this report. The percentage of private patients who complete the treatment is much greater than is the case at the clinic.

TABLE I

	Private	Clinic	Total
No. of case records examined	1,626	3,750	5,376
No. of cases treated with x-rays	325	281	606
Percentages	19.9%	7.5%	11.2%

TABLE II

Sex	Private	Clinic	Total
Males	84 = 25.8%	95 = 33.8%	179 = 29.5%
Females	241 = 74.2%	186 = 66.2%	427 = 70.5%

Table II shows the number of males and females who received x-ray treatment for their acne. The ratio of females to males is about three to one in private practice, while at the clinic it is about two to one. This may indicate that acne is more resistant to medical treatment in females or it may mean that more females refuse treatment that is more disagreeable, troublesome, and less certain to cure promptly.

Table III shows the average age of the patients at the time x-ray treatment was given to be nineteen to twenty years—it does not mean that the acne began at this age. Approximately 65 per cent of the patients were at or just beyond puberty.

⁹ Lord, L. W., and Kemp, J. E., *Southern Med. Jour.*, October, 1931, 24, 867.

Most of the patients in this particular group were about fifteen years of age.

TABLE III

	Private	Clinic	Total
Average age	20	19	
No. treated between ages of 14 and 16	203 = 62.4%	188 = 66.9%	391 = 64.5%

TABLE IV

Clinical results	Private	Clinic
Cured	132—40.6%	108—38.4%
Very much improved	88—27.0%	76—27.0%
Much improved	48—14.7%	39—13.8%
Total	82.3%	79.2%
Improved	41—12.6%	42—14.9%
Slightly improved	8—2.4%	7—2.4%
Failure	8—2.4%	9—3.2%
Total	4.8%	5.6%

Twenty-four patients in cured group had 10 x-ray treatments or less.

Table IV shows the end-results of x-ray treatment of acne cases in both office and clinic. While considerable general medical attention is given our clinic patients, it is not so meticulous as in the office. The fact that the results are about the same in both office and clinic indicates, apparently, one of two things: either that the general medical care at the clinic is adequate, or that when dealing with a large amount of material general medical attention does not materially modify the end-results. Naturally, the latter statement does not apply to individual cases.

It is difficult to decide on the exact definition of the term "clinical cure" in these cases. In Table IV the word "cured" means that the patient had no lesions after cessation of treatment. "Very much improved" means that there was an occasional lesion, but no additional treatment of any kind was necessary. Under "much improved" are grouped the patients who, at times, have several lesions, especially at or near the menstrual periods. It is possible that many physicians would clas-

sify these three groups as cured cases. "Improved" means that after terminating x-ray treatment there was always one or several lesions, and that the patient had to use topical applications and other measures to complete the cure.

It is seen that in the office approximately 50 per cent of the patients were permanently cured in four months or less, about 28 per cent were practically cured, while in 15 per cent the affection was moderately active at times. It seems fair to state that in about 83 per cent of the patients the results were satisfactory, about 12 per cent were benefited to various degrees, while about 5 per cent failed to improve or were complete failures. The clinic figures are a trifle lower.

TABLE V

Recurrences	Private	Clinic	Total
Number	96	92	188
Percentage	29.5%	32.7%	31%

Table V records the relapses that occurred in a few months or within a year or two. They occurred most frequently in unhealthy persons, in persons whose hygiene and habits were not satisfactory, and in patients who received the x-ray treatment at or near puberty. Occasionally a relapse occurred in an adolescent or young adult for which no cause could be ascertained. While the recurrences are high, about 30 per cent, they were, according to the records, mild or moderate in all but about a dozen patients. They occurred in the first three groups of Table IV; therefore it is necessary to reduce the 83 per cent for the combination to about 53 per cent for permanently satisfactory results with one course of x-ray treatment. These figures correspond almost exactly with our 1927 statistics and they approximate the carefully compiled statistics published at about the same time by Michael, and Lord and Kemp.

In the entire series there were a few patients who developed local vasomotor instability during the course of treatment, but only in one instance was it marked.

This patient showed evidence of an "impending erythema" after the sixth treatment, and in this one case x-ray treatment was discontinued permanently. In the others it was interrupted temporarily and resumed later with a smaller dose.

Our statistics include only those patients who were treated with the technic briefly outlined at the beginning of this report: in this series there were no untoward results. A few cases of x-ray sequelae were noted with other technics. The question of scarring is not included in this paper because this subject was carefully studied in the Department of Dermatology, New York Post-graduate Medical School, and reported by Henry D. Niles.¹⁰

We tried a smaller dose on a very limited series of cases, with disappointing results. We are now experimenting with doses of about 37 r and 18 r, with and without strong topical remedies. It will be a year or two before the results are definitely known.

We attempted to analyze the clinic records of acne patients who were treated with methods other than x-rays, but the effort was useless because such a large percentage of patients failed to continue treatment or could not be checked for final results. In the office we are now able to report final results on 422 patients who did not receive x-ray treatment (Table VI).

TABLE VI

Total number patients treated without x-rays.....	422
Number patients cured within six months.....	85 (20.14%)
Number patients cured within two years.....	173 (40.99%)
Number of failures or patients only slightly improved.....	165 (39.09%)
Number of patients with one recurrence.....	58 (13.74%)
Number of patients with two or more recurrences.....	23 (5.5%)

It is seen that this larger series of cases

¹⁰ Niles, Henry D., Arch. Dermat. and Syph., January, 1933, 27, 89.

checks almost exactly with the smaller series of similar cases reported in 1927.

SUMMARY

1. Of 5,376 records of cases of acne vulgaris, 606 patients were given x-ray treatment and continued such treatment until it was discontinued by the physician. Contact with these patients was maintained over a period of years.

2. Four hundred and twenty-two patients were treated without x-rays and remained under observation for several years.

3. Of the 606 patients who received x-ray treatment, approximately 50 per cent received permanent cures as a result of treatment extending over periods of from six weeks to four months.

4. Of the 422 patients treated without x-rays, about 40 per cent were cured in from six months to two years, most of whom required over eight months.

5. Without x-ray treatment, there were approximately 40 per cent failures; with x-ray treatment, failures amounted to about 5 per cent.

6. Complete clinical cures, and almost complete clinical cures were obtained in four months or less with x-ray treatment in about 83 per cent of the patients. Without x-ray treatment, about 62 per cent of the patients were clinically cured in from six months to two years.

7. Recurrences are more frequent when the cure has been effected with than without x-ray treatment—about 30 per cent with x-rays; about 13 per cent without x-rays. In the x-ray series many of the relapses occurred in patients who were below par in general health or who indulged in distinctly injurious habits; also, when the clinical cure was obtained at or shortly after puberty. For this last reason we prefer to hold x-rays in reserve until the patient is well beyond puberty.

8. Not a single patient in this entire series, treated with the technic herein outlined, developed any injurious result from the x-ray treatment.

9. Fewer acne cases are treated with x-rays to-day than a decade or two ago. This is because conventional dermatological management is constantly improving, and because there is a better selection of method and combination of methods for the given case. This trend indicates better medical instruction and training, a better knowledge of the disease and its therapeutic requirements, and an increas-

ing disinclination to travel the path of least resistance; therefore, the trend should be encouraged.

10. Nevertheless, x-ray treatment from the standpoint both of statistics and clinical experience, offers the most certain method of obtaining a clinical cure and even a permanent cure, in the shortest time, especially when combined with adequate general medical attention.

DIFFERENTIAL DIAGNOSIS OF INJURIES OF THE SPINE¹

By HOWARD P. DOUB, M.D., *Detroit, Michigan*

Department of Roentgenology, Henry Ford Hospital

THIS study has been undertaken in order to review the various types of injuries that involve the spine, and the anatomical anomalies and pathological conditions of the spine that may resemble injury, and thus cause confusion. This subject is of great interest in our everyday work among acute cases which are referred for roentgen examination. It is also of surpassing interest to anyone interested in industrial accident cases and medico-legal work.

To anyone studying this subject, it is soon apparent that there are a great number of conditions in the spine which have some points of resemblance to spinal injury. In order to differentiate anomaly and disease from injury it is imperative that one have a comprehensive theoretical and practical knowledge of the subject. The roentgenologist must equip himself adequately for this type of consultation work unless he is willing to leave it to others so qualified.

The development of roentgen apparatus and films has progressed to a point where the roentgenologist can now demonstrate the various parts of the spine to a degree impossible a few years ago. This technical improvement and recent admirable pathological and clinical studies have changed many of our old views and have added new concepts of disease.

Much of the subject matter contained herein has been compiled from the available literature. We have added to this from our experience and material wherever possible.

Compression Fractures of the Spine.—This is the commonest type of fracture found in cases of spinal injury and comprises about 40 per cent of all spinal fractures. It is produced, in most instances,

by forcible hyperflexion or jack-knifing of the spine. This results in extreme pressure on the vertebral bodies with consequent collapse of one or more vertebrae: the area most frequently involved comprises the lower dorsal and upper lumbar vertebrae. The twelfth dorsal or the first lumbar vertebra shows the most frequent involvement, in our series either one or both of these being involved in over 15 per cent of the cases. The lower cervical spine is also a frequent site of injury in persons diving into shallow water. In certain instances more than one vertebra may be involved and an individual vertebra in various areas may be simultaneously involved. Among our cases we found 12 per cent of the cases with multiple fractures in one area and 11 per cent with multiple isolated fractures. These will be discussed later.

A history of injury together with pain referred to a local area, limitation of motion, local tenderness, and kyphosis at that point are the principal clinical findings in fractures of the vertebrae. A history of injury with any of the above signs should lead the clinician to call for a careful x-ray examination. The differential diagnosis should take into account a pre-existing unsuspected lesion, such as tuberculous spondylitis, malignancy, Charcot spine, hypertrophic spondylitis, and generalized osteoporosis with collapse of the vertebrae.

The x-ray demonstration of fracture of the body is the most important evidence in the diagnostic problem. This examination is of great importance in those early cases where the history of injury is so slight or uncertain that one is tempted to forego this expense. These unsuspected and untreated cases are the ones that may result in medico-legal problems or suffer serious disability. In cases where cord

¹ Read before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.

lesions are present, it is also of extreme importance to determine the point for operative procedures and the pathological anatomy that will be encountered.

Compression fractures of the vertebrae are demonstrated roentgenologically to the best advantage in the lateral view: in the typical case the body is compressed anteriorly so that it is triangular in shape. In the cases with considerable compression the diagnosis is made with ease, but in some cases the compression is so slight that the films must be of surpassing quality and even then one must search for minute breaks in the margins of the body. An angulation of the spine either posteriorly or laterally is also quite suggestive in spinal injury. The intervertebral disc tends to show little or no narrowing. This is a differential point in regard to tuberculosis, which shows early destruction of the disc. In some cases, however, the nucleus pulposus is ruptured and these may show varying degrees of narrowing of the intervertebral space. Healed cases also show narrowing or even obliteration of the space, with bony union of the vertebrae. In the anteroposterior view there is narrowing in the superior-inferior diameter and usually widening in the lateral dimension: there may be comminution, with lateral displacement of the fragments. With this condition there is usually seen an associated lateral angulation of the spine.

The reparative process is slow in its appearance since the callus is not abundant and forms slowly. Lipping around the vertebral margins, similar to the changes seen in hypertrophic arthritis, is usually seen after about three months—an attempt by Nature to immobilize the spine at this point. The amount of this bone proliferation is influenced by the care with which the spine has been immobilized and by postural influences. In older persons these changes are more pronounced. In early uncomplicated cases good functional results may be expected in from four to six months when treated by recumbency, with spinal immobility in hyperextension fol-

lowed by gradual activity with a brace or corset. Physical therapy during the latter weeks is of considerable aid. Operative procedures are usually reserved for those cases that do not respond to the conservative treatment, or in which there are extensive fractures of the body and laminae. Operation is also done occasionally as a time-saving measure in order to shorten the period of convalescence. Harbaugh and Haggard (9) state that the results, in fractures of the spine, seen before the California Industrial Accident Commission, indicate practically the same degree of permanent disability from operative and non-operative treatment.

Fracture of Transverse Processes.—Fractures of the transverse processes are most frequent in the lumbar area. They may be produced either by direct violence or by indirect injury caused by extreme muscular pull, produced by hyperextension, with rigidity of the extensor muscles of the spine. Wilmoth (21) believes that the quadratus lumborum is the muscle which has the greatest influence in the production of these fractures. He reports 16 cases of fractures of the transverse processes of the lumbar vertebrae. The muscular pull is also of considerable importance in causing displacement of the fragments after fracture has taken place.

Deep palpation usually discloses pain at the site of the fractures. Movement of the back also causes pain, especially movements which require the use of the muscles of hyperextension and flexion. In certain instances the symptoms are slight and are thought to indicate only a strain.

The x-ray examination will prove to be of great aid in making the positive diagnosis and will show the amount of displacement of the fragments: in most instances these fractures are not associated with fracture of the vertebral body. We found that in 8 per cent of our cases of fracture of the vertebral body there were associated fractures of the transverse processes. Certain text-books state that these fractures of the transverse processes

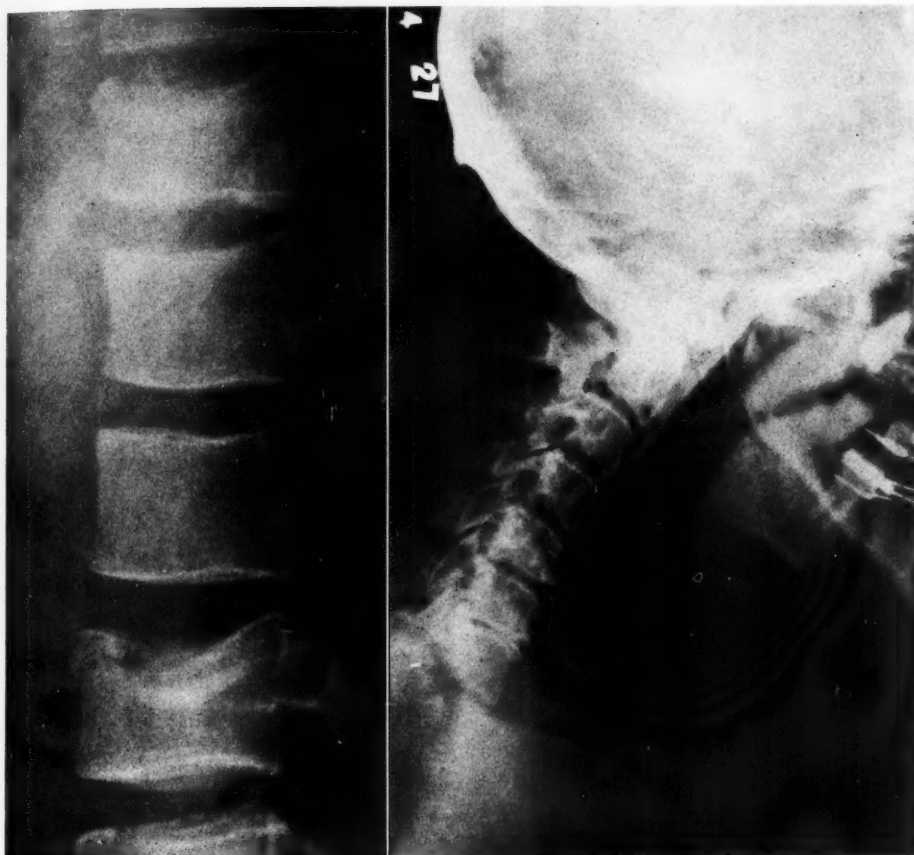


Fig. 1. Compression fracture of two isolated vertebrae with two normal intervening vertebrae.

Fig. 2. Fracture involving laminae of the second cervical vertebra. There may be seen a fracture of the mandible.

are relatively infrequent, but we believe that if a careful roentgen examination be made of all spinal injuries it will be found that they are not uncommon. We have 58 such cases in our files at the present time and have seen many others. Differential diagnosis usually lies between fracture and rudimentary lumbar ribs: the latter usually occur at the first lumbar vertebra and have an eburnated border where they articulate—they very seldom offer any real difficulty in diagnosis.

The fragments usually unite by bony union, except in those instances in which there is considerable displacement. At times transverse processes are seen which

are abnormally angulated or have an irregular contour, but one should be wary about calling these old fractures, as they are commonly seen in routine examinations of this area.

Fracture of the Spinous Processes.—The commonest site for these fractures is in the cervical and upper dorsal area where the spinous processes are more slender; they are rather uncommon in the lower dorsal and lumbar areas. They are also more difficult to see in these areas, due to the thickness of the trunk which requires a relatively long exposure to clearly delineate the vertebral bodies. In our series of cases 80 per cent occurred

in the cervical area and 20 per cent in the lumbar area: none involved the dorsal area.

In our experience they have all been produced by direct violence, but Steindler (19) cites a case, described by Wolff (22), in which the fracture was ascribed to indirect violence due to extreme muscle contracture. Similar cases have been described by others.

Point tenderness can usually be elicited over the area of fracture. Accompanying fractures of the cervical area one finds crepitation, with mobility of the fragments, and the head may show restriction of movement. Immobilization is the only treatment necessary in uncomplicated cases.

Fracture of the Articular Facets.—This fracture usually occurs in conjunction with dislocation or fracture dislocation of the spine, especially in the cervical and lumbar areas. According to various authors it may also occur as an isolated fracture and as such is frequently overlooked and the case treated for strain or lumbago. Mitchell (11) has recently reported five such cases, one of which was of such severity that removal of the fragment and spinal fusion was done. Two of them showed involvement of the superior articular facets and three of the inferior facets. Nichols and Shiflett (13) believe that non-union of anomalous epiphyses at this point may produce this x-ray picture, and report seven such instances. We have seen a number of cases such as might properly be called non-union of an epiphysis occurring at the tip of the facet, but it is significant that in the one case operated on by Mitchell there was fibrous union and microscopically no cartilage occurred between the fragments, as one would expect in the case of an ununited epiphysis.

These facet fractures in the lumbar area are produced by flexion and lateral bending with rotation. In the case of fractures accompanying dislocation there is usually displacement forward of the vertebra on the underlying vertebra. The most prominent symptoms are pain and restriction of motion, with muscle spasm. Treat-

ment usually consists of an application of a plaster cast or a Taylor back brace. If relief is not obtained by these measures, it may be necessary to resort to operative fixation of the affected area.

Fracture of the Neural Arch.—Fractures of the arch are most common in the cervical area and are frequently associated with fracture of the spinous process. In some instances they will be found to be unilateral and in others, bilateral. They are often difficult to demonstrate satisfactorily, but they may be seen in the lateral projection in cases in which the fracture is bilateral and there is displacement of the fragments. In the antero-posterior view the films should always be made stereoscopically.

Fractures of the arch are relatively uncommon as compared to fractures of the other parts of the vertebra and are usually not of very serious import, as the fracture itself tends to relieve pressure on the cord.

Multiple Isolated Fractures.—Multiple isolated fractures of the vertebræ, in which one or more normal vertebræ intervene between the involved ones, have been thought to be relatively uncommon. Schneider (18), in 1930, stated that he could find but 12 reported cases in the literature. To these, he added three of his own cases, all of which occurred in the dorsal vertebræ.

In our series we have 14 such cases, or approximately 11 per cent, which makes it a rather common occurrence. We believe that in cases of severe spinal injury the examination should embrace a considerable portion of the spine and frequently the entire spine.

In analyzing our cases we find two that show three isolated fractures in each, with normal intervening vertebræ. There is an average of four normal vertebræ intervening between the fractured ones. In 13 of the cases at least one of the involved vertebræ was in the dorsal area; in seven, one occurred in the lumbar area, and in three, one occurred in the cervical area. In five instances the fractures occurred in one section of the spine and in nine



Fig. 3. Fracture of spinous process of sixth cervical vertebra. Dislocation between sixth and seventh cervical vertebrae with forward displacement of the sixth.



Fig. 4. Non-union of secondary epiphyseal center of ossification with the vertebral body. These may easily be mistaken for fracture.

cases they involved two sections. They are somewhat more common in the lower dorsal and upper lumbar areas, but the mid-dorsal area is also a fairly common area of occurrence.

The excellent results to be obtained in cases of vertebral fracture after proper treatment make it imperative that none of these multiple fracture cases be missed. It behooves us, therefore, not to examine the local suspected vertebra only, but to include large areas and in many cases the entire spine.

Pathologic Fractures.—The conditions we have been describing are those which result from trauma. We find patients occasionally who show evidence of compression of one or more vertebrae yet have not

been subjected to trauma and in whom the symptoms appear to develop spontaneously or from very slight trauma incidental to our daily lives. In most of these cases the roentgen examination will disclose a pre-existing pathologic disease of the vertebrae which has produced bone destruction, with consequent weakening of the weight-bearing power of the bone. We call these pathologic fractures.

Bone tumors, both benign and malignant, are frequent antedating lesions. Osteomyelitis and tuberculosis also cause bone destruction, with collapse of the vertebral body. One of the most common causes of narrowing of the bodies is generalized decalcification such as that which results from hyperparathyroidism. In

some instances, in which in the early stages it has not shown local manifestations, this condition has been confused with vertebral fracture.

There is no characteristic finding in pathologic fracture, as the picture will depend considerably upon the pre-existing disease. In general, however, the bone structure can be made out in fractures of normal bones, while in pathologic fractures, the normal bone structure will be lost and the characteristic findings of the original lesion may be discerned in many cases. Another diagnostic point which is of great aid is the type of compression of the vertebra. In the various types of pathologic fracture the compression is inclined to be uniform throughout in contradistinction to the triangular shape of the vertebra following trauma, in which cases the narrowing is all anterior, with preservation of the height of the vertebra posteriorly. This finding is by no means invariable but may be used as a valuable aid in diagnosis.

Kümmell's Syndrome.—This condition was first described by Kümmell, who believed it to be a rarefying osteitis of the vertebra, but later he called it post-traumatic disease of the vertebra. He states that the patient had usually received a severe injury to the back, but the x-ray examination was negative at that time. The patient then entered on a period of freedom from symptoms in which he resumed his normal activities. After some months, the patient experienced pain and disability, with deformity of the back. X-ray examination at this time revealed a compression of the body of one or more vertebrae, with wedging anteriorly. The intervertebral disc at this time may or may not show narrowing.

This condition has long been a source of contention among medical men. In order to make the diagnosis, one must have a typical history and a characteristic roentgenogram. The roentgenogram must be negative at the time of trauma and positive later in the course of the disease, conditions which very few reported cases ful-

fill. In most of these cases the spine should not be called negative at the first examination because of inadequate x-ray examination: frequently no lateral view was made, and the spine cannot be called negative without a lateral view.

O'Brien (15) gives it as his opinion that, "what Kümmell has described is unrecognized, hence untreated, fracture of the spine—unrecognized because of no cord symptoms, inadequate or no roentgen examination, and the erroneous belief that if one can walk and has suffered only a slight trauma, one cannot have a fracture of the spine."

Rigler (16) reported one case which appears to fulfill the conditions laid down for this syndrome. At the time of the first examination there were fractures of the vertebrae at areas remote from the area in question, though later the deformity developed in an area that was roentgenologically negative at his first examination.

We have never seen a case that presented all the criteria which characterize this disease. We believe that while the condition may occur rarely, still in most instances it is due to an untreated injury which was missed because of inadequate x-ray examination.

Dislocation.—Dislocation of the spine unaccompanied by fracture is almost always found in the cervical area, since the vertebrae in the dorsal and lumbar areas are interlocked by their spinous and articular processes in such a way that dislocation rarely occurs. In nearly all cases of dislocation affecting these areas there are associated fractures of some of these processes. Dislocation of the coccyx may occur and usually takes place at the sacrococcygeal junction. Oakman (14) described such a case and discussed the literature on this subject.

George and Leonard (8) believe that the atlas, axis, and the base of the skull should be considered as a unit area. They state that the most common lesion in this unit area is forward dislocation of the skull and atlas on the axis, with the skull and atlas



Fig. 5. Congenital abnormalities of the spine and ribs.



Fig. 6. Ununited epiphysis of tip of the spinous process of the seventh cervical vertebra.

retaining their normal relationship. When the dislocation involves the third cervical the members of the upper unit, consisting of the skull, atlas, and axis, are in normal relation to each other and are dislocated on the third cervical.

Dislocation of the cervical spine may be either unilateral or bilateral but the unilateral type is much more common and less serious. In the unilateral type the head is rotated to the side opposite the dislocation and there is abduction to the opposite side. There is muscle spasm but the head can often be manually replaced to the mid-line. The dislocation can frequently be replaced by continuous traction and manipulation. The bilateral dislocation is less common but more serious, and may frequently cause cord changes. There is marked pain and tenderness, with forward flexion. The reposition in the

latter type can be accomplished only by unlocking the facets by forcible traction and then replacing the displacement by manipulation.

In going over our series we found a uniform distribution of the dislocation throughout the cervical area. In all instances but one the dislocation was anterior, the exception to this being a lateral dislocation associated with fracture. In one-half of the cases there was an associated fracture either of the facets or laminae. There were two cases of dislocation of the coccyx and none of the dorsal or lumbar areas, aside from those with major fractures of the vertebrae. These may be classified more accurately under fractures with marked displacement.

Non-traumatic Dislocation of the Atlanto-axial Joint.—In rather rare instances one sees a dislocation of the atlanto-axial ar-

tication in children following an acute upper respiratory infection. Berkheiser and Seidler (1) have reported five such cases, one bilateral and four unilateral. In the unilateral anterior dislocation, the chin deviates to the opposite side, while in the posterior dislocation it deviates toward the same side. There is a torticollis deformity, with fixation and pain on motion.

It is difficult to obtain satisfactory films because of the deformity and, because of this, the diagnosis may be missed. With satisfactory films, Berkheiser and Seidler (1) state that the dislocation is shown as an overlapping of the articulating facets. The lateral view, in the anterior dislocation, shows the anterior arch of the atlas to be displaced forward with respect to the odontoid. Four of their cases were reduced by constant traction in hyperextension and the other by manipulation under anesthesia.

We have seen one case which responded satisfactorily to constant traction.

Spondylolisthesis.—This condition is one in which there is usually a forward displacement of the fifth lumbar vertebra upon the sacrum. Less frequently the displacement may be between the fourth and fifth lumbar vertebrae or even between the third and fourth vertebrae. Spondylolisthesis is relatively common and is much more frequently seen since the lateral view of the lumbosacral area has been routinely used.

It is produced by the transmission of the body weight through the spine to the fifth lumbar vertebra which normally lies on an inclined plane. From the consideration of the articulation of the fifth lumbar vertebra it is obvious that this displacement must be either the result of an acute trauma or there must be an anatomical anomaly which has allowed the displacement to take place. We feel that it is nearly always the result of a congenital anomaly of the spine. The condition may either develop gradually, over an extended period, or acutely, from an injury which the already weakened spine cannot tolerate.

Congenital anomalies are quite common in the fifth lumbar vertebra, and Willis (20) has pointed out that the two centers of ossification for the neural arches may fail to fuse so that a false joint occurs between the pedicle and neural arches or between the pedicle and body. In a series of 748 spines examined he found a separate neural arch in 4.28 per cent of the cases. In 80 per cent of the affected cases the defect was bilateral. Chandler (3) believes that separation of the neural arch in the region of the isthmus is the usual cause of this condition, and in a series of 18 cases he found it in every case.

It is more common in males, especially in those who do heavy labor. The outstanding symptom is backache, which is aggravated by exertion and relieved by rest. Neurologic signs are infrequent because of the level of the lesion, but there may be referred pain and some parasthesia.

Physical examination reveals varying degrees of lumbar lordosis, with prominence of the upper posterior border of the sacrum and spinous process of the fifth lumbar vertebra. The body may appear to be shortened and the pelvis broadened. There may also be local tenderness, with muscle spasm.

The absolute diagnosis of spondylolisthesis depends upon the demonstration of the luxation of the fifth lumbar vertebra by means of the roentgen ray. In the anteroposterior view, the borders of the vertebral body are foreshortened, and in some cases the body can be demonstrated stereoscopically to lie anterior to the sacrum. It is in the lateral projection, however, that we obtain the exact information as to the relative position of the sacrum and the fifth lumbar vertebra. By comparing both the anterior and posterior borders of the vertebrae, one can get exact information as to the amount of displacement and tilting of the fifth lumbar vertebra on the sacrum. Tilting of the vertebra alone, without displacement, is not spondylolisthesis. In this view one can occasionally demonstrate a defect in

the arch. The degree of displacement may vary from a slight displacement to one in which the body of the fifth lumbar vertebra lies almost entirely anterior to the body of the sacrum.

Meyerding (12) recommends conservative treatment by means of casts, braces, and corsets and, if this is not satisfactory, spinal fusion should be done.

Anatomical Anomalies which may Simulate Fracture.—In addition to cases of frank bone injury such as are indicated above, there are many anatomical and pathological conditions which may be mistaken for fracture unless one has a large amount of experience and is constantly on the lookout for them. Cases are constantly going through the courts as fracture cases, which are only anatomical anomalies or disease processes. In many of these cases the correct diagnosis has been missed, while in others there is an honest difference of opinion, especially in chronic cases. We will attempt to describe some of these conditions which may be mistaken for fracture, and point out their characteristics.

Spina Bifida Occulta.—Spina bifida is probably the commonest anomaly found in the spine. Cushway and Maier (4) report that they found 156 instances of this condition in examining the backs of 916 supposedly normal men who were applying for railroad work. Giles (7) reports its occurrence in 23.9 per cent of 1,122 cases. This anomaly may involve any of the vertebræ from the cervical area to the sacrum, but is found more frequently in the lumbo-sacral area. It may involve several of the vertebræ and frequently involves both the fifth lumbar vertebra and the sacrum. By postmortem examination, Geipel (6) found nine cases of spina bifida of the atlas among 260 cases, the cleft varying from a simple fissure to an opening 6 mm. wide.

It is seen to best advantage by roentgen examination when the cleft is in the midline but may occasionally be demonstrated when the lateral portions of the laminae are involved. In some cases the

body of the vertebra also shows an asymmetry, and there may be various other congenital variations associated with it. In most instances the differential diagnosis of spina bifida and fracture presents no difficulty from the roentgen examination. It is quite important for the roentgenologist to be able to recognize the difference between the chronic changes due to spina bifida and the recent changes characteristic of fracture.

Bohart (2), from his study of a large number of railroad workers with known spina bifida, came to the conclusion that this condition is not a hazard in workers. Men with this anomaly were not more liable to injury and disability than others not so affected.

Sacralization of the Fifth Lumbar Vertebra.—A frequent anomaly of the lumbo-sacral area is enlargement of the transverse process of the fifth lumbar vertebra, with either articulation or bony union with the body of the sacrum. It may be unilateral or bilateral. It should never be confused with fracture of the spine, but in several medico-legal cases of which we have had knowledge, it was described as fracture, apparently by an inexperienced person. Bohart (2) has not found this to be a hazard among the railroad employees which he studied.

Anomalous Ribs.—Rudimentary ribs may occur at the level of the first lumbar or the twelfth dorsal vertebra, and they do occur in about 10 per cent of the cases of routine spine examination and may be confused with fracture of the transverse process. In some instances they will be found to be unilateral, but frequently are bilateral. They can usually be differentiated from fracture by the roentgen examination. In anomalous ribs there is always an articulation which shows an eburnated border: it may be rounded and smooth, in contradistinction to the sharp jagged edge seen in fracture of the transverse process.

Cervical ribs may sometimes be confused with fracture of the transverse process, especially when the rib is short. The

roentgen appearance of the articulation is, however, similar to that seen in the lumbar rib and should not lead to confusion with fracture of the transverse process.

Ossification Abnormalities of the Vertebral Borders.—Defective ossification along the borders of the vertebral bodies has recently been described by Hellmer (10). This results in a lack of fusion between parts of the epiphyseal centers and the vertebral body. It is found most frequently in the lumbar area.

The roentgen appearance suggests a small bone fragment separated from the body of the vertebra anteriorly, with a bony defect in the vertebra just beneath it. It may be either on the superior or inferior aspect of the body, although the former is more common. There may be irregular calcification between the body and the separated fragment.

The etiology is unknown but trauma would not seem to be a prominent factor. Hellmer (10) assumes from its general appearance that the defect is caused by abnormal ossification, which fails to unite parts of the secondary epiphyseal center of ossification and the body.

Differential diagnosis between this abnormality and fracture of the same area may be difficult, as the distinction between the two is not always clear-cut. In many instances, however, this abnormality may affect multiple vertebrae, and the adjacent portion of the body frequently has an appearance which is inconsistent with fracture.

Schmorl's Disease.—Schmorl (17), on the basis of pathologic studies of over 8,000 spines, has described the nucleus pulposus of the intervertebral discs. He also described the herniation of the nucleus pulposus into the adjacent vertebra, a herniation which usually occurs when there are perforations of the cartilage plates or in cases in which they are degenerated. On the roentgen film they are shown as rounded depressions in the body of the vertebra just posterior to the mid-portion of the articular surface. There may be a similar process in a number of

adjacent vertebrae. Some irregularity and narrowing of the body of the vertebra may be present, especially if the process dates from adolescence or if there is a generalized osteoporosis. It is these latter cases that may suggest fracture, but the multiplicity of the lesions, the shape of the bodies, and the osteoporosis usually make the diagnosis clear. In these cases the disc is spherical in shape and the vertebral bodies assume a biconcave shape.

In another group of cases the nucleus pulposus is displaced posteriorly from its normal position. In these cases there may be some kyphosis, with narrowing of the vertebral bodies. This can be distinguished from fracture by the fact that multiple vertebrae are usually involved.

Anomalies of Development of the Vertebra.—The development of the vertebral body will not be discussed, except to mention that any interference with the growth of the centers of ossification and their union will produce abnormalities of the body.

To this group of abnormalities, in addition to the anomalies mentioned elsewhere in this communication, may be added hemibody, complete absence of a body, fusion of two or more bodies, and rachischisis.

The Klippel-Feil syndrome is characterized by a congenital absence of one or more cervical vertebrae, with deformity of others. It is productive of great deformity of the neck. There is little likelihood of its being mistaken for fracture.

Pathologic Conditions Which May Simulate Fracture.—In addition to anatomical anomalies which may be mistaken for fracture of the vertebrae, there are a number of disease processes which must be differentiated from fracture.

Spinal Tuberculosis.—In tuberculosis of the spine the shape and appearance of the vertebra will depend upon the anatomical site of the infection in the vertebral body and the length of time the infection has been present, as has been pointed out previously by us (5). A vertebra which is the seat of a central type of infection of the body may collapse and show a trian-

gular shape very similar to fracture of a normal vertebra. In practically all cases of tuberculosis of the vertebræ, however, there is definite narrowing of the disc. This is not present in recent fractures of the spine, so that the differentiation is seldom difficult. In some old healed cases, with abundant bone production, the two conditions may be quite similar, as the disc may disappear in old fracture cases.

There is no conclusive evidence at hand which would tend to show that injury may be the inciting factor in tuberculosis of the spine.

Neoplastic Deformities.—Neoplastic lesions are frequently found in the vertebræ and may cause deformities which must be differentiated from injury.

Metastatic carcinoma is by far the most common type of tumor found in the spine. It is divided into two types, depending upon the amount of bone destruction and proliferation, viz., (1) osteoblastic, (2) osteoclastic.

Osteoblastic carcinoma of the vertebra is manifested by an increased density of the bone, with loss of the normal trabeculation, so that the vertebra stands out sharply in comparison to the surrounding vertebræ. The shape of the body is usually maintained, so that there is very little chance of its being confused with fracture.

Osteoclastic carcinoma is characterized, in its early stages, by areas of lessened density representing bone destruction. These areas may progress until the structure of the bone is so weakened that it can no more support the body weight, and collapse occurs. In many cases the collapse of the body is shown as a uniform flattening. In some instances the destruction may be in the lateral portion of the body, in which case there results a lateral angulation of the spine at that point. In many cases it can be differentiated from traumatic fracture by the presence of metastases in other bones, and these should be sought. The type of destruction, however, will usually make the

diagnosis clear. Obliteration of the disc is unusual, except in late cases.

Osteogenic sarcoma is more difficult of diagnosis until, in the later stages, when the surrounding tumor, often containing areas of bone proliferation, will aid in determining the correct diagnosis.

Multiple myeloma is not common, but may produce very marked deformity of the vertebræ. There may be collapse of the bodies of a great number of the vertebræ, but in the early stages it is not unusual to see a single vertebra involved. We have seen two cases in which collapse of a single vertebra made the differential diagnosis from fracture difficult until other vertebræ showed similar changes.

Benign tumors, such as giant-cell tumors and cysts, are not commonly found in the spine, but the former may produce marked deformity and distress in the later stages. It is not likely to be mistaken for fracture.

Hyperparathyroidism.—In cases of hyperfunction of the parathyroid glands there is mobilization of the blood plasma calcium, which is taken largely from the skeletal system, the great storehouse of calcium in the body. In such cases there is a generalized osteoporosis, with softening of the bones and resultant deformities.

In the spine the softened vertebræ are unable to maintain the body weight and various deformities result. There may be compression of the bodies of one or more of the vertebræ, especially in the mid-portion and lower dorsal and upper lumbar areas. This compression of the vertebræ is seen both anteriorly and posteriorly, with a biconcave narrowing quite different from the triangular shape seen in fracture. The intervertebral discs are not narrowed. There may be scoliosis and exaggeration of the anteroposterior curves of the body. The general picture does not simulate fracture to any great degree and the differentiation is not likely to be difficult. The generalized osteoporosis will usually aid greatly in making the diagnosis clear.

DISCUSSION

We have tried to list above most of the commoner types of spinal injury and the anatomical and pathological conditions that may be confused with injury. In most instances the differential diagnosis is not difficult. There are certain instances, however, in which, because of atypical findings, recourse should be had to all the clinical findings in the case. In many conditions the roentgen findings are not typical in the early stages and knowledge of the clinical findings will be the means of an early diagnosis. If one maintains a healthy skepticism and a proper balance of clinical judgment, he is not apt to read into the film false values.

Various clinical factors must be taken into consideration when expressing judgment on roentgen films of the spine. The age of the patient is of great importance and one must recognize the changes that characterize each age period. This applies especially to patients over fifty years of age in whom hypertrophic changes incident to age may be considered under the heading of a true or traumatic arthritis. A knowledge of these hypertrophic changes is of great importance in industrial accident cases, in which they are often attributed to injury. If the spine is examined immediately after injury and hypertrophic changes are present, their relation to the injury can be ruled out. If the patient is not seen until several months after the injury, these changes are frequently attributed to the injury. Hypertrophic changes, however, have a rather characteristic appearance. They begin at the vertebral margins and extend toward the spur on the body of the adjacent vertebra. These spurs very rarely unite unless there are other influences that change their characteristics. The bone proliferation seen after injury to the vertebrae is usually a protective mechanism and tends to bridge and immobilize the vertebrae, acting in a similar manner to a bone graft.

Occasionally cases of back injury are seen which are roentgenologically negative at the time of injury but which show partial or complete bridging of the vertebrae in the affected area after an interval of several months. Such a case represents a reparative process from a slight undetected injury to the vertebra and surrounding soft tissues, and is not similar to an arthritic change.

Very little difficulty is to be encountered in the diagnosis of true acute fractures of the vertebral body and its appendages, with the exception of the technical difficulties encountered in demonstrating the lesion clearly. It must be recognized, however, that the type of fracture and the portion of the vertebra involved will vary, depending upon the area of the spine involved. Thus, it is recognized that while compression fractures of the cervical and upper dorsal areas may occur, they are not the usual occurrence, and when present will often vary from the standard type of compression. In the cervical area fracture is usually an accompaniment of dislocation.

Patients who have had an injury some months before and those who have an indefinite or slight history of trauma often present a difficult problem, especially if there are changes in the spine which vary from the normal appearance. Often anatomical anomalies are incorrectly diagnosed as fractures. It is this class of case that is provocative of so much litigation in the industrial accident courts. In a great percentage of these cases there should never be any diversity of roentgenologic opinion, as the diagnosis is self-evident to any roentgenologist of experience. A considerable source of this confusion is the legal practice of allowing any physician to qualify as an expert in roentgenological diagnosis by his own statement. This practice can be overcome only by the medical profession setting up definite standards of specialism and encouraging the courts to adhere to these standards.

SUMMARY

A brief discussion of some of the clinical and roentgenologic features of injury of the vertebral body and appendages has been given. Most of the commoner types of anatomical anomalies that might be confused with fracture have been outlined.

A few disease processes that are sometimes confused with injury of the spine have been discussed briefly.

We have kept in mind throughout this discussion the medico-legal aspect of the subject and have referred to it occasionally.

REFERENCES

- (1) BERKHEISER, E. J., and SEIDLER, F.: Non-traumatic Dislocation of the Atlanto-axial Joint. *Jour. Am. Med. Assn.*, 1931, **96**, 517-523.
- (2) BOHART, W. H.: Significance of the Anatomical Variations of the Symptomless Spine from the Surgical and Industrial Standpoint. *Illinois Med. Jour.*, 1929, **55**, 356-360.
- (3) CHANDLER, F. A.: Lesions of the Isthmus of the Laminae of the Lower Lumbar Vertebrae and Their Relation to Spondylolisthesis. *Surg., Gynec. and Obst.*, 1931, **53**, 273.
- (4) CUSHWAY, B. C., and MAIER, R. J.: Radiological Studies of the Anatomical Variations Observed in the Symptomless Spine. *Illinois Med. Jour.*, 1929, **55**, 355, 356.
- (5) DOUB, H. P., and BADGLEY, C. E.: Tuberculosis of the Intervertebral Articulations. *Am. Jour. Roentgenol. and Rad. Ther.*, 1931, **25**, 299-307.
- IDEM: The Roentgen Signs of Tuberculosis of the Vertebral Body. *Am. Jour. Roentgenol. and Rad. Ther.*, 1932, **27**, 827-834.
- (6) GEIPEL, P.: The Knowledge of Spina Bifida of the Atlas. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1930, **42**, 583-589.
- (7) GILES, R. G.: Vertebral Anomalies. *RADIOLOGY*, 1931, **17**, 1262-1266.
- (8) GEORGE, A. W., and LEONARD, R. D.: The Vertebrae Roentgenologically Considered. P. B. Hoeber, Inc., New York, 1929.
- (9) HARBAUGH, R. W., and HAGGARD, R. E.: Fractures of the Spine. *Calif. and Western Med.*, 1930, **32**, 325-330.
- (10) HELLMER, H.: Roentgenologische Beobachtungen ueber Ossifikationsstörungen im Limbus Vertebrae. *Acta Radiologica*, 1932, **13**, 483-517.
- (11) MITCHELL, C. L.: Isolated Fractures of the Articular Processes of the Lumbar Vertebrae. *Jour. Bone and Joint Surg.*, 1933, **15**, 608-614.
- (12) MEYERDING, H. W.: Spondylolisthesis. *Jour. Bone and Joint Surg.*, 1931, **13**, 39-48.
- (13) NICHOLS, B. H., and SHIPLETT, E. L.: Ununited Anomalous Epiphyses of the Inferior Articular Processes of the Lumbar Vertebrae. *Jour. Bone and Joint Surg.*, 1933, **15**, 591-600.
- (14) OAKMAN, C. S.: Traumatic Luxation of the Coccyx. *RADIOLOGY*, 1931, **17**, 727.
- (15) O'BRIEN, F. W.: Unrecognized Vertebral Fracture versus Kümmell's Disease. *RADIOLOGY*, 1931, **17**, 661-673.
- (16) RIGLER, L. G.: Kümmell's Disease, with Report of a Roentgenologically Proved Case. *Am. Jour. Roentgenol. and Rad. Ther.*, 1931, **25**, 749.
- (17) SCHMORL, G.: The Pathological Anatomy of the Intervertebral Discs and Their Relations to the Vertebral Bodies. *Arch. f. orthop. Chir.*, 1931, **29**, 389.
- (18) SCHNEIDER, C. S.: Double Isolated Compression Fracture of the Spine. *Jour. Bone and Joint Surg.*, 1930, **12**, 595.
- (19) STEINDLER, A.: Diseases and Deformities of the Spine and Thorax. C. V. Mosby Co., St. Louis, 1929.
- (20) WILLIS, T. A.: Vertebral Anomalies. *Am. Jour. Surg.*, 1929, **6**, 163-168.
- (21) WILMOTH, C. L.: Fractures of the Lumbar Vertebra Due to Hyperextension and Extreme Muscular Action. *Jour. Am. Med. Assn.*, 1928, **91**, 6-8.
- (22) WOLFF, G.: Typische durch Muskelzugentstandene Abrissfraktur der unteren Hals, und Oberen Brustwirbeldorne. *Beitrag. klin. Chir.*, 1922, **132**, 145.

THE TREATMENT OF CHEST-WALL SECONDARIES IN BREAST CARCINOMA

A PRELIMINARY REPORT OF A NEW RADIUM TECHNIC¹

By G. E. RICHARDS, M.D., *Toronto, Canada*

Associate Professor in Radiology, University of Toronto, and Director, Department of Radiology, Toronto General Hospital

FOLLOWING the surgical treatment of primary carcinoma of the breast, the problem presented by recurrent lesions in the skin and subcutaneous tissues of the chest wall has been one of great complexity and attended by many disappointments to the radiotherapist.

a dose of roentgen rays which will be evenly distributed over the entire area and at the same time effective. In the opinion of the present writer, this problem is impossible if large areas are used; if numerous smaller areas are used there also arises the difficulty of joining these together so per-

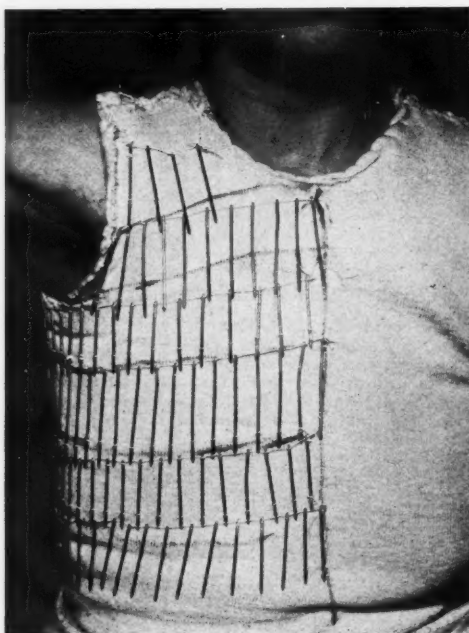


Fig. 1. Front view, showing the felt distance filter in place with the needles stitched to the felt. The needles are "staggered" so as to obtain a more even distribution.

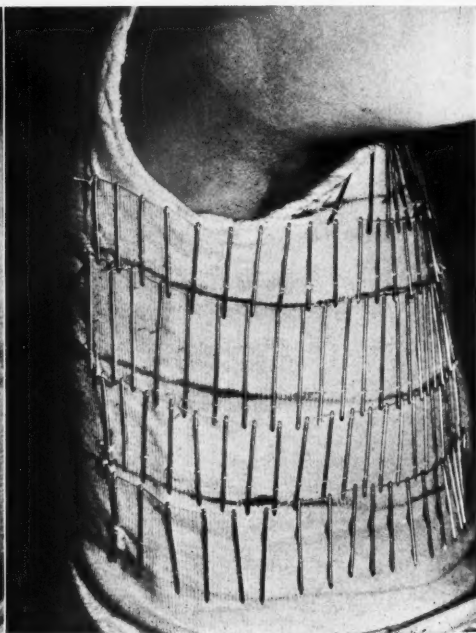


Fig. 2. A side view, showing the distribution of the jacket coming well around to the back. In this particular case, there was no involvement high up in the axilla, and the jacket did not extend into the axilla or along the arm. In some cases a sleeve is used, extending throughout the axilla and down along the under surface of the arm as far as necessary.

The first technical difficulty in applying x-rays to this problem is that of delivering to the curved surface of the thoracic wall

perfectly that there shall be no bands or ribbons of tissue at the points where the various areas meet, which are either under- or over-treated.

The next difficulty presented is the neces-

¹ Presented before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.



Fig. 3. Showing the finished jacket in place, held by small adhesive straps for the purposes of the photograph. In actual treatment, these are heavily reinforced and the jacket is then held in place by means of padding and a flannel bandage.



Fig. 4. Another view of the jacket in position.

sity of delivering a comparatively heavy dose of radiation from a single portal of entry to the thin layer of tissue represented by the skin and subcutaneous tissues, beyond which lie the pleura and lung—structures which are moderately sensitive and comparatively easily damaged by roentgen rays. Apart from the occasional case of a highly sensitive tumor, the majority of these lesions are in the class of resistant tumors and require maximum doses if anything better than growth restraint is to be hoped for from the treatment. The layer of tissue thus represented does not usually exceed 3 cm. in thickness and quite frequently is not more than 1 cm. thick. Therefore, the technical problem which confronts us is to deliver within this thin layer of tissue an evenly distributed, fully effective dose of high intensity radiation, the penetration of which

will be limited to the chest-wall and will not damage the pleura or subjacent lung.

Because so much has been written on the mode of dissemination of secondaries in the chest-wall, it may be assumed that all are familiar with the prevailing theories, and time need not be taken up in discussing these. One point only may deserve further emphasis, *viz.*, it must never be lost sight of in treatment that in between the visible or palpable nodules one should assume the presence of small islands of cells which are invisible to the eye and cannot be palpated with the finger, but any or all of which may develop if not adequately treated. Therefore, the primary object of treatment is to include every particle of skin throughout the chest-wall from the mid-line in front around the axilla, preferably to the mid-line of the spine posteriorly,



Fig. 5. Showing the type of reaction which has been produced in very extensive cases. This reaction is slightly more severe than is necessary and is only used in very extensive disease. In this case, it extended well up into the axilla and along the under surface of the arm, as well as over the whole chest-wall and supraclavicular area.

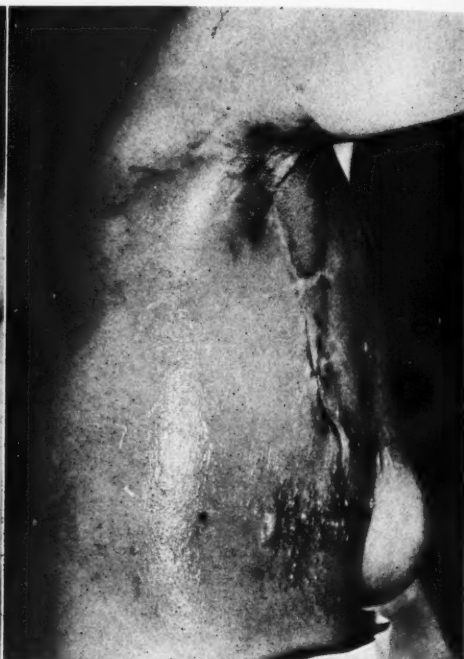


Fig. 6. A side view of the previous case, demonstrating the extent of the reaction which in this case shows marked vesication.

and from the clavicle above to the lower thoracic margin below.

Having felt disappointed with the available methods some years ago, we undertook to treat this type of recurrence by unfiltered x-rays, and pushed this to the point of producing reactions of the first, second, and even third degree over the entire chest-wall. Because it was found that the penetration possible by using soft roentgen rays was not adequate for the purpose, and also that the reactions, which were painful, healed very slowly, we finally came to the conclusion that this was not the solution of this particular problem, although in many cases it offers a very useful adjunct to prevailing methods and probably should be made use of more frequently than is the case at present. It is doubtful, however, if this method of treatment

should be used over areas larger than about six inches square, as the reactions are moderately painful and tend to heal slowly with considerable scarring and telangiectasis later.

Finally, after numerous experiments, we adopted the method here reported which has now been in use for over a year and which seems to offer a satisfactory answer to more points in the problem than any other method which we have been able to discover up to the present time. The shortcomings of this method will be pointed out a little later.

The method consists in fitting to the patient's body a radium applicator which we have called "the radium jacket." The foundation of this jacket consists of a layer of felt half a centimeter thick which is accurately fitted to the patient's body by



Fig. 7. Showing the type of reaction produced by a modified jacket which did not extend over the whole chest-wall.

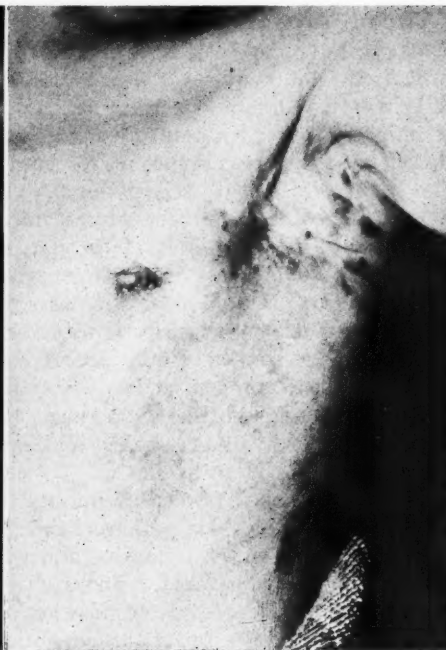


Fig. 8. Showing the type of case which is considered suitable for treatment. This one happens to be a primary lesion in which no surgical operation has been done, and clinically is well on the way to becoming a cancer *en cuirasse*. This case is still under treatment, having already made remarkable improvement following the application of the radium jacket.

the dressmaker. To this, in the original form of the jacket, rows of radium needles were stitched as shown in the photograph, and accurately spaced from each other, so arranged as to provide a perfectly even irradiation of the entire chest-wall, from the mid-line in front around posteriorly as far as it was thought desirable to extend the jacket. In some cases this has gone as far as the mid-line of the spine. Later, in order to minimize the handling of needles and the stitching of them in place, containers were made by which the needles are slipped into pockets. These pockets are prepared in long strips and any number can be cut off to suit the individual case. They are laid on the felt and held in place by adhesive. When sufficient needles have been attached to the felt to cover the de-

sired area, the whole package is enclosed in pure gum rubber and sealed, and in this form is applied to the patient's chest. It in turn is bandaged in position, and the patient wears the jacket for a period of time which is determined by the radium content of the needles and the filtration of their wall. The needles, 60 mm., in length, which have been used for this purpose, contain three milligrams of radium element, and have a wall thickness of 0.8 mm. of platinum of the standard platinum iridium type. Approximately 100 of these needles are used in the full radium jacket and, with the very high filtration resulting in a hard gamma ray radiation and the distance from the skin, it is necessary to leave them in position from 90 to 100 hours in order to secure the desired effect.

The reaction which follows is a fairly severe first to second degree erythema with vesication and requires very particular care in its treatment. Occasionally, it is accompanied by temperature and constitutional symptoms sufficient to require the hospitalization of the patient. The treatment which has been found most satisfactory to the comfort of the patient is the application of a cream consisting of zinc oxide and castor oil, equal parts by weight, which is applied immediately following the removal of the jacket and until the reaction has entirely healed. The cream is applied thickly on gauze, the bandage being changed morning and evening.

Many modifications of this method of treatment are possible in patients in whom the secondaries are less extensive and who do not require a full jacket. For this purpose, local packs of any dimension or shape may be made up for application to local areas along the line of incision or elsewhere on the chest-wall. For deep involvement in the axilla, the radiation is not considered sufficiently penetrating nor is it recommended under these circumstances.

This treatment has been tried out in a different type of case, and the results so far secured are promising, but further information will be necessary in order to completely evaluate the method. These have been very advanced cases in which a prompt local recurrence would be expected from the ordinary surgical method of treatment. In addition, the length of time required for adequate pre-operative radiation was impossible owing to the patient's circumstances. Accordingly, a radical operation was done and the radium jacket applied immediately following the healing of the skin flap. The treatment is considered a prophylactic precaution against local recurrence in the chest-wall or axilla. Up to the time of the writing of this paper, there has not been a case in which local secondaries developed following the procedure outlined.

Results of Treatment.—In the earlier cases treated by this method, the disease was of a very extensive nature and considered quite hopeless by all the available standard methods of treatment. In the majority of these cases, the local lesion disappeared following the application of the jacket, but later remote metastases developed and it is doubtful if the lives of these particular patients were prolonged to any extent by the treatment.

In a more favorable group of cases, however, in which remote metastases were not present and the local secondaries were less extensive, the results have been extremely satisfactory, and it has been felt that the method presented a definite improvement over existing available methods. The present report is offered as a preliminary one, and if the early favorable results are substantiated by further work, a more detailed report will be made at a later time.

Disadvantages of the Method.—The two disadvantages of this method up to the present time are as follows:

1. In several cases there has been a rather severe constitutional reaction, accompanied by temperature and a moderate degree of shock which has required the hospitalization of the patient for several weeks.

2. If the treatment fails to control the disease, it results in a fairly marked degree of devitalization of tissue and subsequent treatments by any method are rendered difficult or impossible.

In spite of these and a number of other minor objections, the results in those cases which have been observed have been distinctly superior to anything we have seen in our own work by other methods of treatment. Also, it appears to offer at least an alternative method of treatment in a difficult field, having the great advantage of a highly penetrating hard gamma radiation, which can be applied over a very wide area and yet does not penetrate so deeply as to damage the underlying delicate structures of the lung and pleura.

THE CUMULATIVE DOSE WITH MULTIPLE FIELDS¹

By M. C. REINHARD and H. L. GOLTZ, *Buffalo, N. Y.*

From the State Institute for the Study of Malignant Diseases, Burton T. Simpson, M.D.,
Director

IN A recent publication (1) the authors endeavored to point out that when the protracted method of radiation is used, the mere statement of total dose gives insufficient information concerning the accumulation of the so-called radiation effect in the skin. It was also indicated that if increments of the order of those ordinarily used in therapy were applied at one-, two-, or three-day intervals, there resulted a condition of equilibrium in the area radiated, when the loss of radiation effect per day compensated the increment added on that day; but if the increment were larger a condition of equilibrium was not attained, and the cumulative dose curve reached a definite peak. The maximum value of this peak was arbitrarily selected as 2,000 r (tissue dose), which, according to Mattick (2), represents a very marked reaction of the skin, bordering on epidermolysis. No cumulative dose calculated using a loss coefficient of 0.08 per day for effective wave length of 0.16 Å., and charted in the previous paper, reached a peak or a condition of equilibrium exceeding 2,000 r.

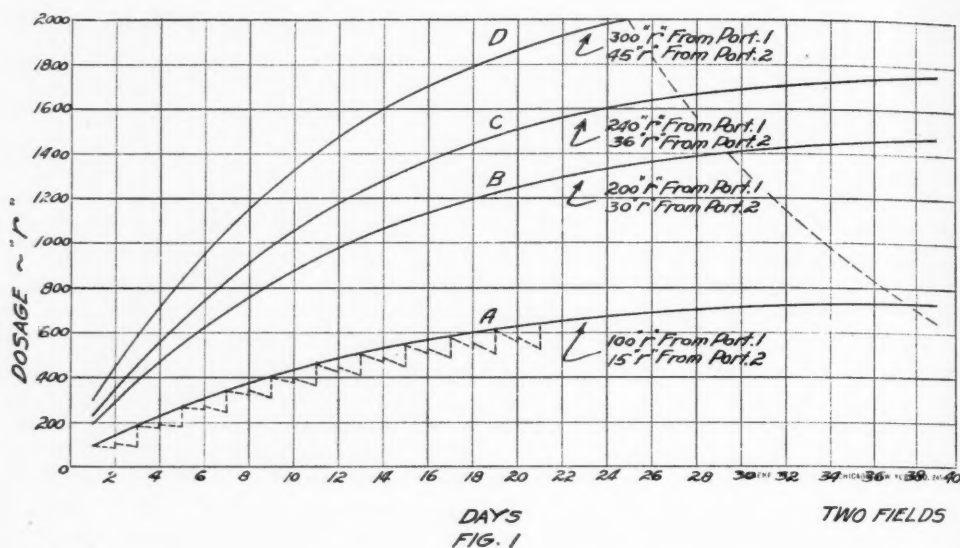
The present paper is a continuation of the first, but whereas the first paper dealt with the skin doses with single fields, this paper refers to the doses accumulated in the skin when multiple ports of entry are used in such a way that there is overlapping of the beams at the various ports. However, when calculating the doses accumulating in the skin under these conditions, the problem is more involved.

In the first paper, where one field was used, it was possible to calculate and construct cumulative dosage curves to fit actual working conditions. With multiple ports of entry, however, this cannot be

done, because with opposite fields, the amount of radiation penetrating to the opposite skin will depend on the target-skin distance, the field size, the diameter of the part irradiated, and to a lesser extent on the wave length, while with adjacent fields the amount of overlapping will vary depending on the proximity of the fields, in addition to the factors mentioned above. Therefore to construct standard curves for multiple fields which would be comparable to those published for one field, it would be necessary to make individual curves to satisfy all of the variables mentioned. We have, therefore, based our calculations on two-depth intensities representing no particular combination of factors.

When a beam penetrates an appreciable thickness of tissue, there is a change in wave length. It has been shown by Quimby and McNatten (3) that a beam of radiation having a half value layer of 0.45 millimeter of copper at the surface is changed in quality to one having a half value layer of 0.26 millimeter of copper after passing through 10 centimeters of tissue. Weatherwax (4) has shown that as the wave length changes the loss of radiation effect per day also changes. We should use, therefore, a larger loss coefficient for the beam from the second port, since its wave length has been increased due to the scattering process. However, in cases in which the diameter of the part irradiated is small, the change in wave length is slight, and therefore the use of the loss coefficient associated with the incident beam will produce an error so small as to be negligible. On the other hand, when the diameter is large, the change in wave length is greater, but in this case the relative intensity is reduced to such an extent that the use of the large coefficient

¹ Accepted for publication June 23, 1934.



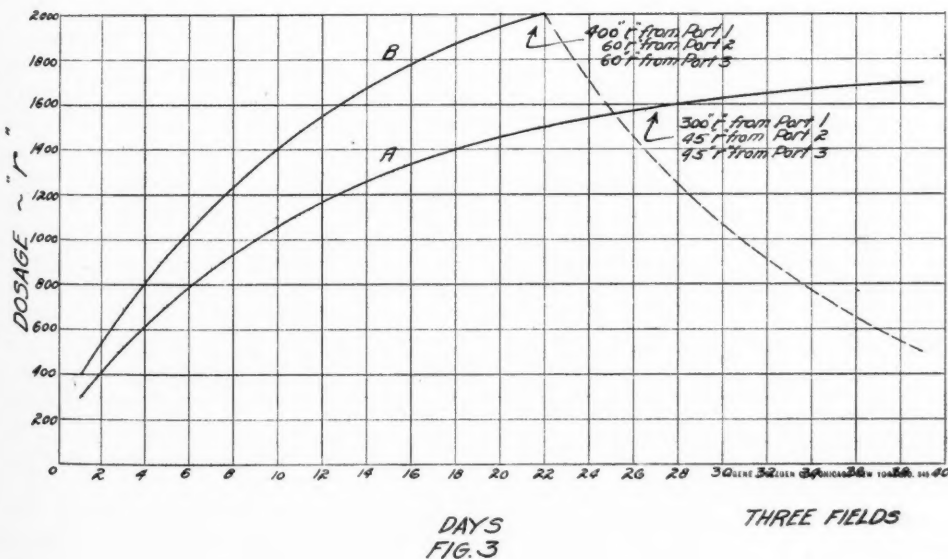
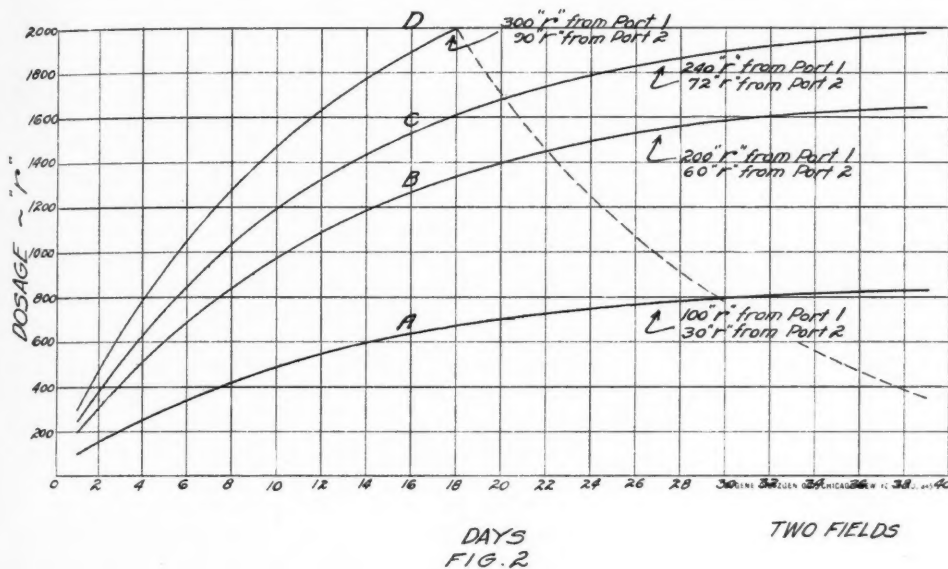
with a small intensity would not change the net result sufficiently to warrant its use. Furthermore, the error resulting from this disregard of the variation in the loss coefficient with the wave length is on the safe side, since the loss is greater than that calculated and the actual cumulative dose is, therefore, slightly less than the calculated dose, leaving a margin of safety.

In addition to the loss coefficient varying with wave length, there is also the problem of the variation of dosage with wave length when combining two doses of radiation of different qualities. For example, when radiating a pelvis with an anterior and a posterior port, the anterior skin may receive a total dose of 2,000 r of effective wave length 0.16 Å. and in addition, from the posterior port, a total dose of 400 r, which by virtue of the Compton effect may have an effective wave length of 0.24 Å. In order to simplify the calculations, we are forced to disregard this variation in dosage with wave length, and have combined the two values as one dose. In disregarding this variation the error introduced will tend to balance that mentioned in the preceding paragraph.

The cumulative doses as presented in this paper are, therefore, subject to these criticisms and represent approximate values. The purpose of the calculations is to emphasize the possibilities of arriving at conditions of equilibrium by varying the increment, and to point out the relation between the total and the cumulative dose, rather than to give specific information as to definite dosage. The two depth intensities mentioned earlier have arbitrarily been selected as 15 per cent, to represent a typical depth dose with large diameters, and 30 per cent, to represent a typical depth dose with small diameters.

Calculations of the cumulative dose have been made using various increments with both depth intensities and a loss coefficient of 0.08 per day. The results of these calculations when two fields are used are shown in Figure 1, in which the increments are 100 r, 200 r, 240 r, and 300 r, with a depth intensity of 15 per cent; and in Figure 2, in which the same increments are used with a depth intensity of 30 per cent. For the sake of clearness and brevity, only the cumulative dosage values immediately following the treat-

ments to the first portal are plotted on these graphs. The broken line of Curve A in Figure 1 shows the increment added the radiation applied to the second port, with the accompanying loss within the next 24 hours, followed by the addition of



on one day to Port I, the accompanying loss within the next 24 hours, the small addition to the skin of the first port from the full increment to Port I, etc. In this case the first port received alternately 100 r and on the following day 15 r from the

second port. The daily depreciation is shown by the downward slope and the amount added by the perpendicular line.

CHART I.—TWO FIELDS RADIATED, ALTERNATING DAILY

	Dose		Increment	Total days	Status
	Total	Cumulative			
Direct	2,000 r				
*15%	300 r				
Total	2,300 r	740 r	100 r	40	equilibrium
Direct	2,000 r				
*30%	600 r				
Total	2,600 r	840 r	100 r	40	equilibrium
Direct	4,000 r				
*15%	600 r				
Total	4,600 r	1,450 r	200 r	40	equilibrium
Direct	4,000 r				
*30%	1,200 r				
Total	5,200 r	1,650 r	200 r	40	equilibrium
Direct	3,900 r				
*15%	702 r				
Total	4,602 r	2,010 r	300 r	25	peak
Direct	2,700 r				
*30%	810 r				
Total	3,510 r	2,000 r	300 r	18	peak
Direct	4,800 r				
*15%	720 r				
Total	5,520 r	1,780 r	240 r	40	equilibrium
Direct	4,800 r				
*30%	1,440 r				
Total	6,240 r	2,000 r	240 r	40	equilibrium
THREE FIELDS ROTATED DAILY					
Direct	4,200 r				
*15%	585 r				
*15%	585 r				
Total	5,370 r	1,700 r	300 r	40	equilibrium
Direct	3,600 r				
*30%	990 r				
*30%	990 r				
Total	5,580 r	2,020 r	300 r	34	peak
Direct	3,200 r				
*15%	420 r				
*15%	420 r				
Total	4,040 r	2,000 r	400 r	22	peak
Direct	2,280 r**				
*30%	600 r				
*30%	600 r				
Total	3,480 r	2,000 r	400 r	16	peak

* Radiation received by the skin of the first port from the increment applied to the other port or ports.

** The increment on the sixteenth day was reduced from 400 r to 280 r in order to avoid a cumulative dose exceeding 2,000 r.

It is evident from the curves in Figures 1 and 2 that increments of 240 r or less, when applied to two fields alternating daily with the depth intensities shown, produce a condition of equilibrium at dosage levels less than 2,000 r. Were these increments to be used at greater time intervals or should there be skips due to

Sundays and holidays, the level of equilibrium would be considerably lower.

As shown by Curves D in Figures 1 and 2, increments of 300 r reach a peak value of 2,000 r in 25 days with a transmitted intensity of 15 per cent, while with a transmitted intensity of 30 per cent from the second portal, a peak is attained in 18 days. The dotted lines of Curves D in Figures 1 and 2, and Curve B in Figure 3 show the loss from day to day following the attainment of the peak condition. A similar loss, of course, follows conditions of equilibrium when the treatments end. Obviously, larger increments would reach this peak in a shorter time.

From the preceding discussion as well as from the information published in the previous paper, it is evident that when the time interval is increased the increment should be increased in order to obtain a peak value, otherwise the cumulative dose reaches a condition of equilibrium at a low level. This is particularly significant when three or more ports of entry are used, and the treatments are rotated so that each field is radiated every third day, as is frequently done in therapeutic practice. Assuming that a field is radiated with a dose of 100 per cent, and that the depth intensity at this point is 30 per cent from the two other ports (15 per cent from each), the calculations of the cumulative dose with 300 r and also with 400 r per field per day are shown graphically in Figure 3. The cumulative dosage curve for the 300 r increment (Figure 3, Curve A) reaches a level of equilibrium at about 1,700 r, whereas the curve for the 400 r increment (Figure 3, Curve B) reaches a peak of 2,000 r on the twenty-second day. Dosage increments less than 300 r, given in this manner, would, of course, build up to a lower level of equilibrium.

When four or more portals are used and the treatments are rotated daily so that each port is radiated every fourth day, the loss of radiation effect from any one of the fields is considerable before that field is again radiated. Therefore, in order to build up the dosage to a high

level of equilibrium or a peak of 2,000 r, it is necessary to use larger increments. For example, a dose of 400 r every fourth day, with 15 per cent, or 60 r, being contributed from each of the other three fields on each of the intervening days, would result in a condition of equilibrium at a cumulative dosage level of 1,950 r on or about the fortieth day, whereas a dose of 500 r every fourth day with 15 per cent being contributed from the other three fields on the intervening days, would result in a peak of 2,000 r after only three weeks.

A comparison of the total dose with the cumulative dose for the various increments and depth intensities mentioned is given in Chart I. This comparison emphasizes

the fact that the mere statement of the total dose gives no clue to the cumulative or, as it is sometimes called, the effective dose.

The total amount of radiation compared with the cumulative values as calculated, for the following conditions, is given in chart form.

BIBLIOGRAPHY

- (1) REINHARD, M. C., and GOLTZ, H. L.: Total Dose *versus* Cumulative Dose in Radiation Therapy, *RADIOLOGY*, August, 1934, 23.
- (2) MATTICK, WALTER: Our Changing Concept Regarding Skin Dose with Some Notes on the Production of Epidermolysis. To be published.
- (3) QUIMBY, E. H., and McNATTEN, R. F.: The Change in Quality of Roentgen Rays in Passing through Tissue. *Am. Jour. Roentgenol. and Rad. Ther.*, 1932, 28, 236.
- (4) WEATHERWAX, JAMES L.: Physics of X-ray Therapy, Hugh A. Lound, 1931.

THE CLINICAL SIGNIFICANCE OF PNEUMOPERITONEUM¹

By LEWIS J. FRIEDMAN, M.D., *New York City*

Director of Roentgen-ray Department, Bellevue Hospital

THE clinical significance of pneumoperitoneum varies with the mode of entry of a gas into the peritoneal cavity. The presence of a gas in the abdominal cavity can be demonstrated fluoroscopically

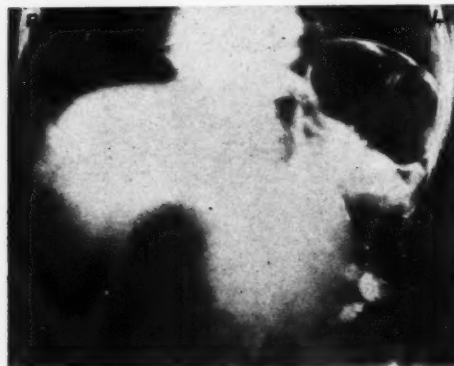


Fig. 1. A case of ruptured duodenal ulcer. The arrows point to the presence of air in the subphrenic spaces.



Fig. 2. The arrows point to the almost complete obscuration of the subphrenic space on the right, by an abscess which has extended into the thorax.

cally and radiographically, therein lying its importance clinically. Roentgenologically, the presence of a gas intra-abdominally is recognized by a dark semilunar shadow in the subphrenic spaces. Although no definite determination has been made as to the smallest amount of a gas that will cast a

shadow, it is believed that as little as 50 c.c. may be visualized on an x-ray film.

Pneumoperitoneum may occur spontaneously or it may be induced for diagnostic purposes. It is also employed as a therapeutic measure in tuberculous peritonitis.

Spontaneous pneumoperitoneum is produced when rupture of a hollow viscus occurs. Lesions predisposing to this accident are as follows: gastric or duodenal ulcer; ileal ulcer complicating typhoid fever; rupture of the urinary bladder, and perforating abdominal wounds.

Cortle and Spalding (1) found the roentgen-ray demonstration of pneumoperitoneum in a perforated ulcer to be of more value than the search for diminished liver dullness. Other observers (2) report the presence of air in the subphrenic space in from 50 to 85.7 per cent of bonafide perforated ulcers. In the few cases the author has observed, all revealed a pneumoperitoneum. In rupture of the urinary bladder, the introduction of air through the urethra resulted in its accumulation in the subphrenic spaces.

Induced Pneumoperitoneum.—Occasionally, air is introduced into the peritoneal cavity during an attempted pneumothorax. For diagnostic purposes, it is usually injected transabdominally; in the female the abdominal cavity may also be filled with air by transuterine insufflation.

While it is true that the use of pneumoperitoneum for diagnostic purposes has been developed into a practical and safe procedure, its employment has been relegated to the past several times, since its original description by Kelling, in 1902, and Stewart and Stein (3) in 1919. It is frequently forgotten to-day in the maze of diagnostic methods. To Sante (4), of St. Louis, much credit is due for reducing the rather intricate methods of older investigators to a technic which is of value for its sheer simplicity.

¹ Accepted for publication April 30, 1934.

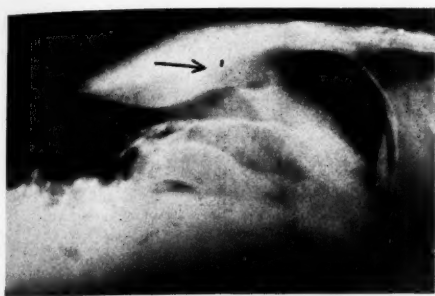


Fig. 3. The arrow in this photograph points to induration of the abdominal soft tissues at the site of a liver abscess. Note the absence of air between the visceral and parietal peritoneum.

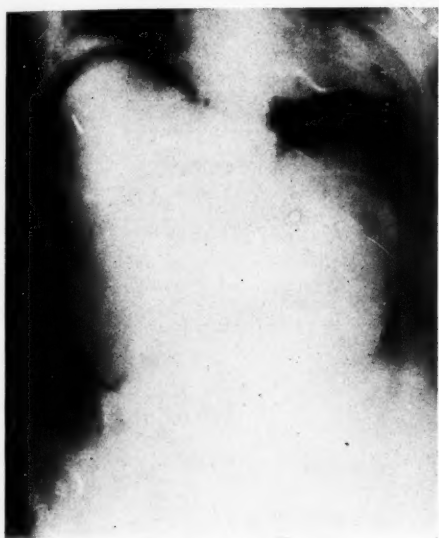


Fig. 4. A case of carcinoma of the liver. The irregularity in contour of an enlarged liver and fixation is apparent.

Induced pneumoperitoneum for diagnostic purpose is a comparatively innocuous procedure and the indications for its performance may be briefly outlined as follows:

1. To differentiate basal intrathoracic pathology from subphrenic disease. A subphrenic abscess will prevent the accumulation of air in the subdiaphragmatic space.

2. To study the liver outline. A liver abscess, if superficial and "pointing," will



Fig. 5. In the absence of a hemidiaphragm, the production of pneumoperitoneum also causes a pneumothorax. The resulting pneumothorax and the collapsed lung can be seen above the coils of intestines. Film reproduced here was taken in the right lateral decubitus position.

be clearly visualized especially if the surface of the liver is adherent to the parietal peritoneum. This phenomenon can be clearly seen on films taken in the lateral decubitus and supine positions.

3. To determine the relation of a mass in the left upper quadrant to the spleen.

4. To differentiate eventration from herniation or absence of a leaf of the diaphragm.

5. To demonstrate and study the relative position of a retroperitoneal neoplasm to normal structures.

6. To study the uterus and adnexa for semi-pedunculated sub-serous tumors, ovarian neoplasms, or cysts. If a film of the pelvis is taken in a modified Sims' position and loops of intestine are retained, the presence of adhesions can be presumed.

The contra-indications for diagnostic pneumoperitoneum vary with the method of introduction of the air.

1. The contra-indications in the transperitoneal method are as follows: (a) enormous ascites; (b) extreme obesity; (c) acute peritonitis; (d) repeated laparotomies, and (e) seriously impaired heart.

2. The contra-indications in the transuterine method comprise the following in addition to those mentioned above: (a) pregnancy; (b) menstruation; (c) suppurative processes of the genital tract, and (d) acute adnexal inflammation.

The dangers of pneumoperitoneum are extremely few, and although hazards were not encountered by the author, they must be considered. The few casualties that have occurred according to the reference in

2. Puncture of the inferior or superficial epigastric arteries is a possibility, but the simple expedient of removing the cannula and re-inserting it above or below the course of the artery will correct the evil.

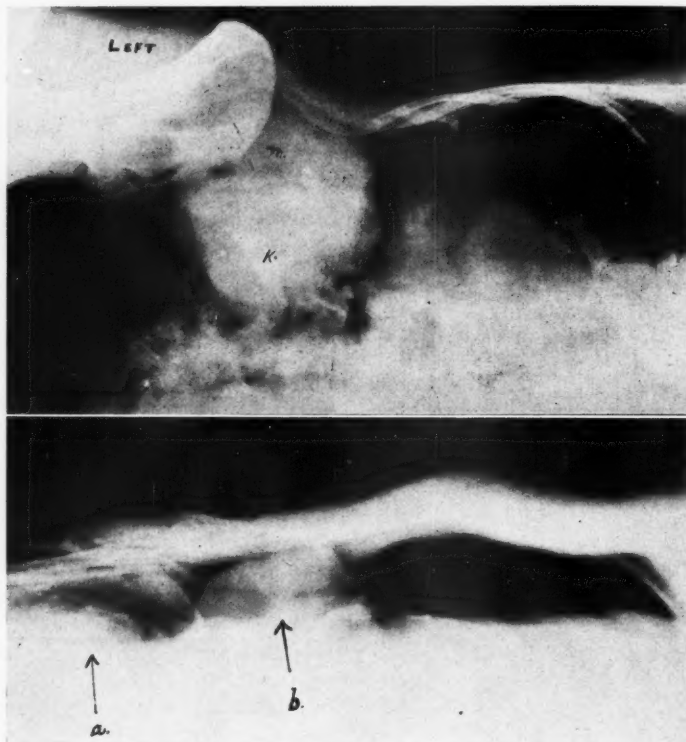


Fig. 6. Copy of radiograph taken in the right lateral decubitus position. Observe the fixation and size of the mass (*m*) which is anterior to the kidney (*k*) (the roentgen rays were directed postero-anteriorly).

Fig. 7. A radiograph of the same patient as shown in Figure 6, taken in the lateral supine position. The arrow *a* points to the loops of the intestines; the arrow *b* points to the tumor situated in front of the kidney. At operation, a large cyst containing a sebaceous material was found at the site reported.

the literature are credited to the early era of experimentation with this diagnostic method. It is reasonable to assume that, with more careful selection of patients, no serious results should be encountered. The following complications, however, must be considered:

1. Embolism; this theoretical possibility of fatality is dismissed from practical consideration by most investigators.

3. Perforation of the bowel. Jacobæns, of Stockholm, who revived this diagnostic procedure in 1910, proved by his experiments on cadavers the inability to puncture the hollow viscera on piercing the abdominal wall.

4. The production of subcutaneous emphysema may result if the needle has not been entirely introduced. However, the accumulated air is rapidly absorbed, and no ill effects are usually experienced.

Preparation of the Patient.—It is advisable that an aperient be administered the night before, and a cleansing enema be given within the hour or so preceding the examination. The urinary bladder must be emptied either by voiding or catheterization. It is also advisable that one-sixth grain of morphine sulphate with atropine be administered fifteen minutes before the examination to allay fear and apprehensiveness. The gases employed for this procedure are carbon dioxide, oxygen, or pure air. For all practical purposes, air, in spite of its slow dissipation, is a suitable contrast medium in diagnostic pneumoperitoneum since it causes no disagreeable effects.

Technic.—1. Transuterine inflation may be accomplished providing one or both tubes are patent, and it should obviously be performed in married women only. For diagnostic purposes, about 700 c.c. to one litre may be introduced, or until the liver dullness is obliterated.

2. The transabdominal route. Surgical asepsis must be observed. The lumbar puncture needle with the stylet *in situ* is inserted slowly but persistently at a point one and one-half inches to the left and below the level of the umbilicus until the peritoneum is perforated. At the moment the peritoneum is pierced, the patient usually experiences a sudden sharp pain and the operator will feel as if an empty cavity has been entered. The needle is then connected to a Potaine aspirator.

Auscultation of the abdomen will reveal a loud gurgling sound as the piston is plunged into the barrel of the syringe. The absence of this sound indicates that the needle has not entered the abdominal cavity. When assured that the needle has been properly introduced, about 1,000 c.c. of air is slowly injected, or until the liver dullness is obliterated.

Radiographs are then taken in the following positions: anteroposterior; right and left lateral decubitus; right and left lateral supine, and sitting. For the study

of the pelvic viscera, particularly in the female, the pelvis is elevated about 28° and the exposures made in the anteroposterior and postero-anterior positions. Usually the patient experiences a sense of fullness within toleration. Should undue discomfort occur, the needle may be re-introduced and the air liberated.

CONCLUSIONS

1. The presence of air intra-abdominally, in other than induced pneumoperitoneum, has an important clinical significance.

2. Pneumoperitoneum naturally has its limitations, and its promiscuous use is inadvisable. As one author aptly cautioned, "Don't do this work for idle curiosity."

3. Pneumoperitoneum and intrauterine instillation of iodized oil, when used conjointly, will yield more diagnostic information, in some cases, than either procedure alone.

4. In the use of this diagnostic procedure, the co-operation between either the surgeon, gynecologist or internist, with the roentgenologist, is imperative.

REFERENCES

- (1) CORTLE, G. F., and SPALDING, O. B.: *Ann. Surg.*, 1927, **85**, 450.
- (2) MATTINGLY, C. W.: *New Orleans Med. and Surg. Jour.*, 1931, **84**, 18.
- VAUGHAN, R. T., and SINGER, H. A.: *Surg., Gynec. and Obst.*, 1929, **49**, 593.
- WOLFSON, W. L., and GRAY, I.: *Ann. Surg.*, 1929, **89**, 264.
- (3) STEWART, W. H., and STEIN, A.: *Roentgen-ray Study of the Abdominal Organ Following Oxygen Inflation of the Peritoneal Cavity*. *Am. Jour. Roentgenol.*, November, 1919, **6**, 533.
- (4) SANTE, L. R.: *Simplified Pneumoperitoneum Technic*. *Am. Jour. Roentgenol.*, October, 1922, **9**, 618-622.
- (5) VAN ZWALEWENBURG, J. G.: *Pelycography*. *Jour. Radiol.*, March, 1922, **3**, 74-79.
- (6) STEIN, I. F., and ARENS, R. A.: *Iodized Oil and Pneumoperitoneum for Gynecology*. *RADIOLOGY*, June, 1927, **8**, 494.
- (7) SANTE, L. R.: *The Detection of Retroperitoneal Masses by Aid of Pneumoperitoneum*. *Am. Jour. Roentgenol.*, March, 1921, **8**, 129.
- (8) VAN ZWALEWENBURG, J. G., and PETERSON, R.: *Pneumoperitoneum of the Pelvis*. *Am. Jour. Roentgenol.*, January 1921, **8**, 12.
- (9) RUBIN, I. C.: *Subphrenic Pneumoperitoneum*. *Am. Jour. Roentgenol.*, March, 1921, **8**, 120.
- (10) PETERSON, R.: *X-ray after Inflation of Pelvic Cavity*. *Surg., Gynec. and Obst.*, August, 1921, p. 154.

By WILLIAM M. MILLAR, M.D., *Cincinnati, Ohio*

THE purpose of this paper is: (1) to present a new instrument of precision for microscopic use; (2) to present certain quantitative data regarding radium exposed tissue obtained by this method.

namely, the application of its principles to such laboratory methods. After considerable experimentation, the following electrical set-up as shown in Figure 1 was designed, found suitable, and adapted. Figures 2 and 3 show the method applied

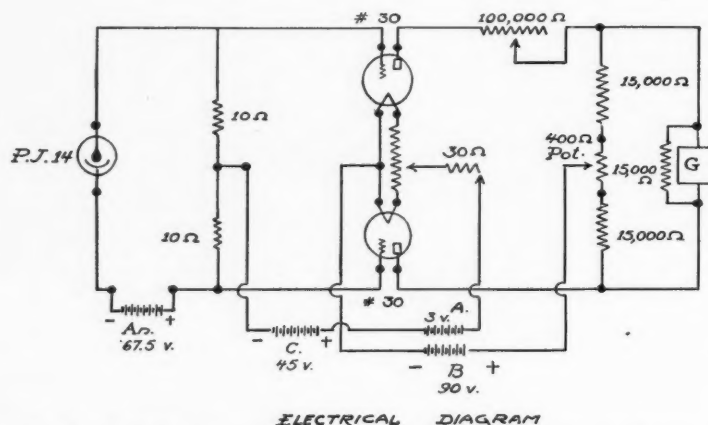


Fig. 1. Electrical diagram of the apparatus used throughout the experiments.

The desire for suitable quantitative methods of measurement in microscopic work has repeatedly emphasized itself to biologic workers, and in the measure of opacity or nephelometry has been chiefly dependent upon various dyes and dilutions. But these are cumbersome and impracticable when applied to a living tissue under the high power microscopic lens. The recent spectacular advance of the photo-electric cell in various lines of industrial activity suggested a solution,

Explanation of Figures 2 and 3.—The unit of measurement used is a centimeter candlepower. The tissue to be radiated is placed under the microscope (Fig. 3). The light (Fig. 2), in this instance a single socket 32-candlepower automobile globe, is placed at an arbitrary distance (60 to 70 cm.) from the microscope. Suitable lenses are used to make the light beam as nearly parallel as possible, and this is deflected up to the mirror through the tissue to the prism² attached

² The prism is made by the Spencer Lens Company of Buffalo, N. Y.

to the microscope. About 95 per cent of the light is said to be deflected to the side-piece while the rest goes up through the micro-adjusters ('D' and "D"). The light (G) is turned "on" and the change noted. The bulb "carriage" is then adjusted

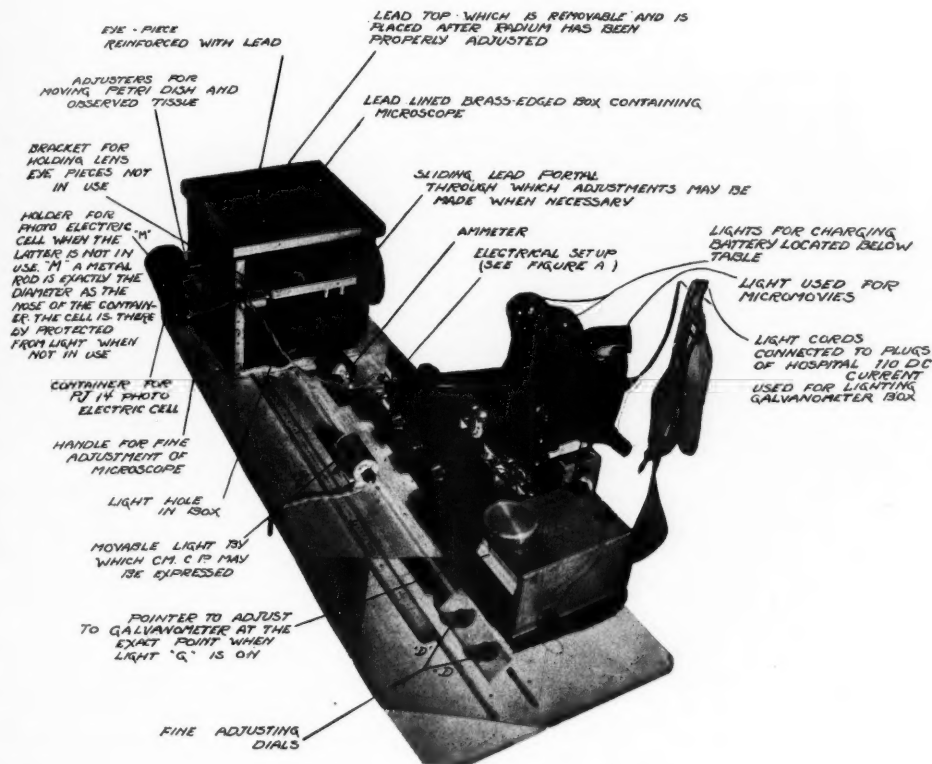


Fig. 2. Photograph of apparatus used.

usual eye-piece. The container, with a G. E. photo-electric cell (P. E. No. 14), was attached to the former (Figs. 2 and 3).

The string galvanometer (K) is then adjusted so that when the light (G) is "on," the indicator will remain at a certain fixed place on the scale. The light (G) is turned off, and the swing of the indicator noted and marked by the needle (S). Whenever a reading is desired, the indicator is brought to this exact position, shown by the needle (S), by means of the

(either closer or farther away from the object), and the distance required to bring the indicator to the former mark noted. In this way the opacity change of the observed tissue is recorded in centimeter candlepower on the scale (F).

PART TWO

In 1916, Grasnack noted that radium produced an opacity in microscopically observed tadpole tissue, when it was exposed to adequate radiation. This

was independently confirmed by us, in 1932. The desire to obtain quantitative data lead to the development of our

Procedure.—The tadpole was anesthetized with chloretone solution,³ placed in a Petri dish, and the high-power micro-

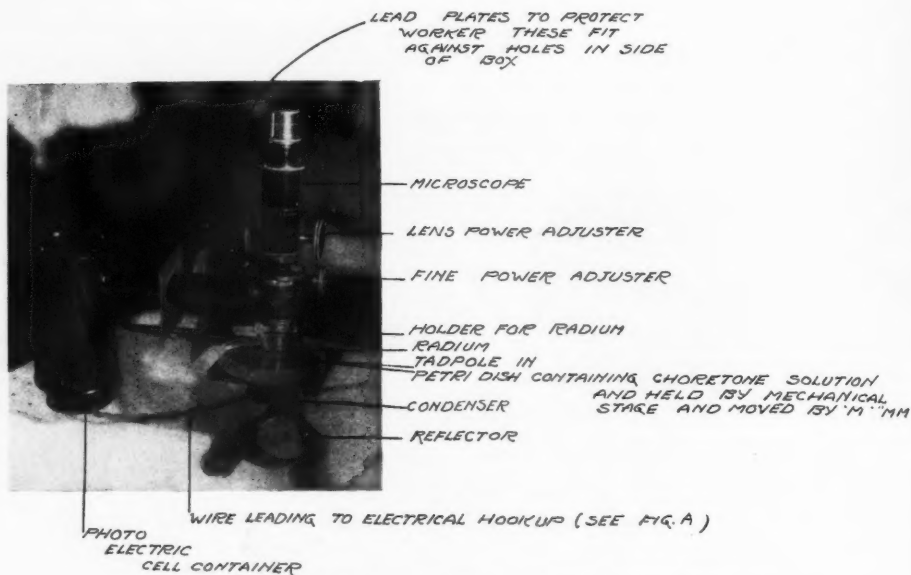


Fig. 3. Photograph of microscope, showing the attached photo-electric cell.

photo-electric nephelometer and its application to further and more complete observations. In a study of the tadpole tail, data were recorded which can best be shown in Figure 5.

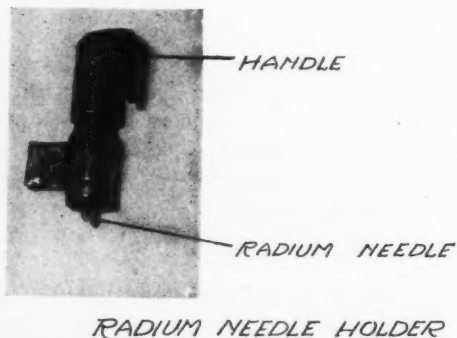


Fig. 4. Photograph of radium needle holder, which is attached to the microscope.

scope focused upon it. A constant position was secured by using a small piece of folded lead to fasten the tail and to present oscillation. The nephelometer was then used in the manner described above, the readings were taken at given intervals.

Radium.—Six needles, each with 12.5 mm. of radium placed at their points, were used throughout the experiments. The wall thickness of each needle was stated to be 0.5 centimeter of platinum. They were fastened firmly to the microscope by means of the holder illustrated in Figure 4. The center of this 75 mm. "ring" was always kept at the same distance (1 cm.) from the center of the lens or the point of magnification.

³ Other narcotizing solutions were also used to rule out the possibility that the chloretone alone was responsible for the observed changes.

It will be concluded by the results plotted in the two lines in Figure 5 that radium causes an increase in tissue opacity.

played a very important part and that the greater the rate of blood flow (measured by the number of capillaries in the field

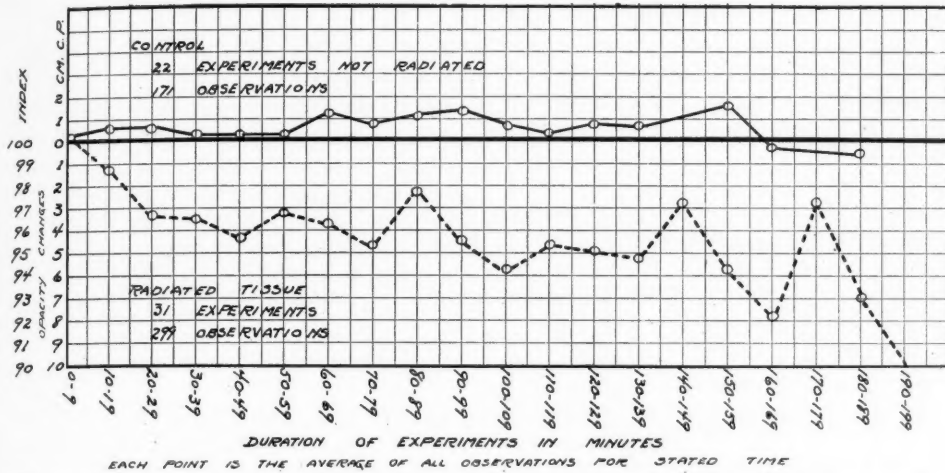


Fig. 5. Graph showing: (a) Opacity changes in 31 experiments (299 observations); (b) no increase in opacity of the controls—22 experiments with 171 observations.

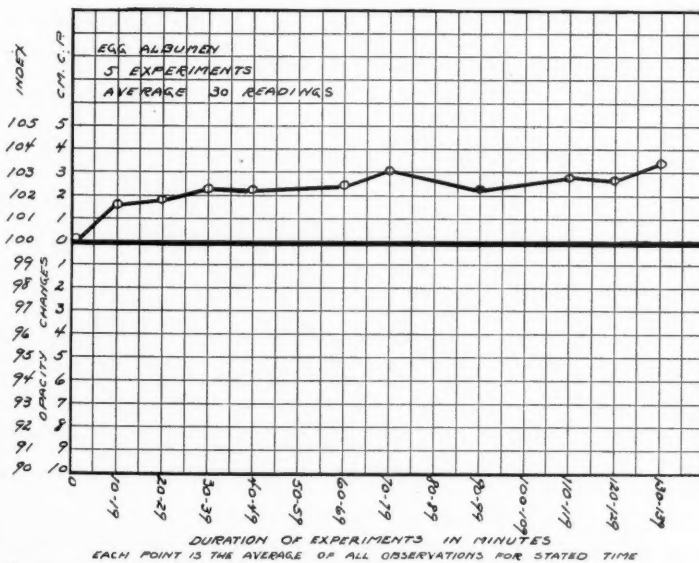


Fig. 6. Graph of radiated egg albumen, showing no immediate increase in opacity.

But what is the reason for this phenomenon? When further studies were completed it appeared that the circulation

and the rapidity of motion of the corpuscles within them) that was present the less rapid and less marked was the

amount of opacity produced. Apparently, the opposite condition was also equally true. In a field in which the observer's eye could not note capillaries or moving cells, the change would proceed with fair rapidity, and about one and a half to two hours were necessary to cause complete opaqueness. This gradual spread of opacity can best be compared by the increasing shadow of the sun during an eclipse. It also would seem that, if the degree of radiation was not too greatly prolonged, a partly reversible reaction would occur. In other words, there would be some diminution of clouding after the radium was removed. The suggestion was made that the change of density might be due to a protein coagulation and that, in order to prove or disprove this, a semi-lucid medium which contained this constituent should be taken and tested in a similar manner. This was done. At first, the ordinary bacteriologic dextrose-acetone agar was used, and no clouding was noted. But the just criticism was made that this did not contain a sufficient amount of protein, so pure egg albumen was substituted. The re-

sults are shown in Figure 6, where it is readily seen from the plotted curve that no coagulation of material (with its resulting opacity) occurred.

CONCLUSIONS

1. A new quantitative instrument for microscopic study is described.

2. Its application to radium-exposed tissue showed the following: (a) That radium, in tadpole tissue exposed to it, gave a demonstrable change in opacity which could be measured in centimeter candlepower units; (b) from certain data obtained, it would seem that this change was dependent upon the circulation present in the observed field.

The author wishes to thank Dr. J. L. Ransohoff for the generous use of his radium: J. L. Ross for his valuable electrical and technical aid; Jacob Link for the construction of the lead box used in these experiments, and Miss Mary Maciel for her photographs and graphs.

REFERENCE

- (1) GRASNICK: Arch. f. Mik. Anat., Bonn, 1917, 90, 1-38.

PYELO-PERISTALSIS CHARACTERISTICALLY ALTERED BY INFECTION, WITH NOTES ON FUNCTIONAL BEHAVIOR OF OTHER HOLLOW VISCERA¹

By H. A. JARRE, M.D., and R. E. CUMMING, M.D., *Detroit, Michigan*

From the Departments of Roentgenology and Urology, The Grace Hospital

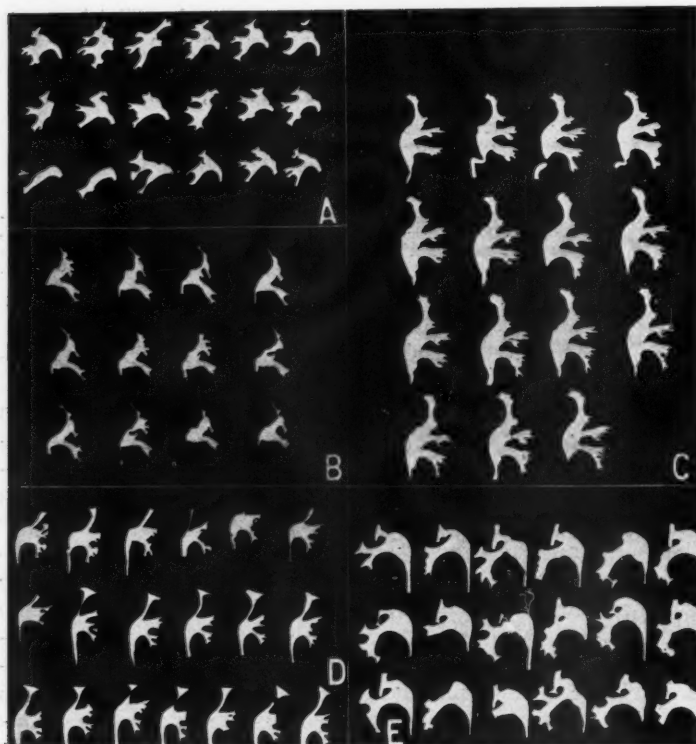
WELL co-ordinated function of the various organs of our body is of greater importance to our well-being than perfect anatomic structure. Functional re-adaptation often compensates for irreparable anatomic deficiencies, with which some are or may become afflicted. No thinking roentgenologist will deliberately omit functional investigations. However, we are quite inconsistent in roentgenologic recording and evaluation of function; for instance, very few of us in our routine roentgenologic reports mention the functional status following recovery from bone or joint injuries, although at least some observations of functional ability might be quite easily obtained from either fluoroscopic or radiographic study and could be of value to the attending physician, his patient, or a court. We usually find included in gastro-intestinal reports remarks on the type and behavior of gastric peristalsis, stressing at times the fact that abnormal behavior drew attention to an anatomic lesion; but when the colon is concerned, we very frequently are led to regard temporary functional configuration as pathologic anatomy (colitis), and hardly ever make an effort to obtain information concerning true colonic activity. Six-, 24-, and 48-hour observations are poorly evaluated and are more and more regarded as a useless waste of time and effort. Functional changes after administration of a barium enema are hardly ever studied; yet the problem of constipation alone would warrant more careful analysis, although such might be quite time-consuming. What percentage of chest examinations includes correct notes on the function of all demonstrable intrathoracic structures? How frequently is

the marked elasticity of the infantile mediastinum misinterpreted as evidence of thymic disease? The physiology of the urinary passages is very rarely studied by roentgenologic methods, etc.

Since the advent of excretion pyelography, we are facing new problems of function, of which we were less conscious during times of exclusive retrograde urography. Figure 1A, which shows 18 different images of the same renal pelvis, was obtained by serial-excretion pyelography during 30 seconds. Undoubtedly, pronounced variations in the pyelographic appearance of renal pelvises similar to these shown are observed by many roentgenologists and urologists. What is their significance? Which of these 18 images represents the normal configuration of this renal pelvis? Can one rely for correct interpretation on a few single pyelograms obtained at random following the intravenous injection of the opaque medium? To what extent may "blunting" of calices be regarded a reliable sign of infection?

When attempting an interpretation of this variable appearance of the renal pelvis during excretion pyelography, we must take into consideration the existence of considerable muscle tissue in the urinary transportation tracts, which is well known since J. Henle's publication, in 1866, in the "Handbuch der Systematischen Anatomie des Menschen." He describes in detail the renal anatomy, including the muscle coat of the pelvic mucosa and the "sphincter papillae." He also indicates that this muscle mass should have a definite function. His painstaking, classical observations still must be regarded as correct, though a few authors have added minor details. J. Disse, in 1902, re-investigated the muscular elements of the renal pelvis and described strands of longitudinal

¹ Presented before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.



Case 4 (Fig. 1-D). Miss F., E. L. *History*: Traumatic transverse myelitis. Paralysis of bladder treated by permanent retention catheter. Previous cystitis healed. Normal renal function and blood chemistry. *Duration*: Four years since spinal fracture. *Organisms*: None. *Roentgen diagnosis*: Normal. Notice complete contractions of various segments and re-filling from periphery.

Case 5 (Fig. 1-E). Mr. B., R. E. *History*: No disease of this kidney demonstrated. Opposite kidney removed two weeks before—gonorrhoic pyonephrosis. *Roentgen diagnosis*: No anatomic pathology. Increased capacity and alternating, quite active peristalsis are probably result of increased load before complete compensation.

Case 1 (Fig. 1-A). Miss F., E. R. *History*: See Series 1-D. *Roentgen diagnosis*: Normal. Very pronounced activity. No two images are alike. Which single image represents the normal? Note occasional "blunting" of calices.

Case 2 (Fig. 1-B). Mrs. T., E. L. *History*: During recovery from acute pyelonephritis. *Duration*: Six weeks. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: No anatomic pathology. Functionally—failure of complete calical contractions—residual evidence of infection. Note the three cycles of peristaltic waves in the upper infundibulum.

Case 3 (Fig. 1-C). Mrs. B., L. I. *History*: Chronic pyelonephritis on opposite side. This kidney not demonstrably infected. *Roentgen diagnosis*: Anatomy normal. Alternating, weak peristalsis—chiefly middle calyx, pelvis, and ureteral bulb. Probably some of the inhibition is due to instrumentation.

Explanation of abbreviations: Pyelography: E—Excretion; I—Instrumental; R—Right; L—Left.

muscle fibers between the sphincter papillæ of Henle, and the fornix calicis, which have connections to the renal capsule. He expressed the opinion that these muscle fibers must have the ability to approximate the sphincter to the fornix. Furthermore, he noted regularly a relatively strong band of circular muscle fibers at the junction of calices and renal pelvis. He believed that these muscle fibers may be sufficiently strong to completely occlude and separate the calices from the pelvis

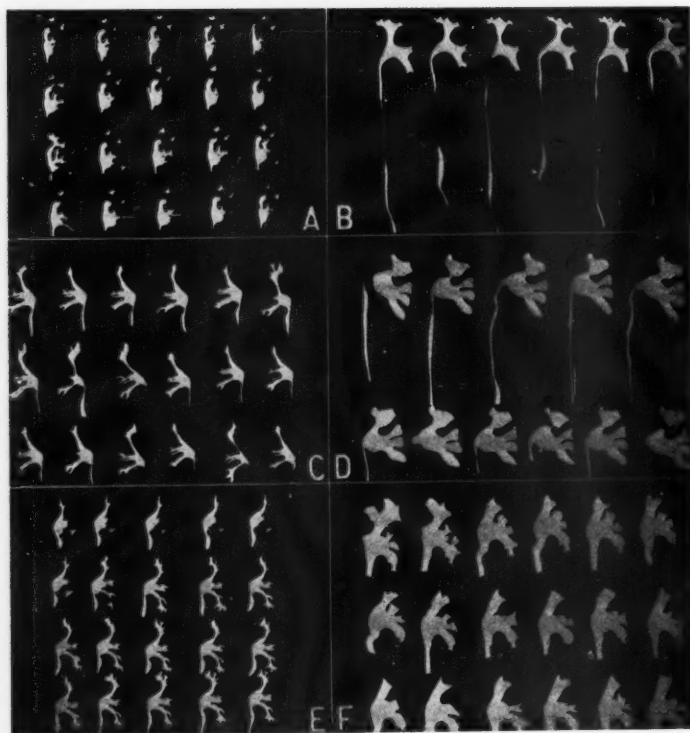
proper. Westenhoefer, in 1914, stated that intraglomerular pressure alone was insufficient to transport urine from the glomerulus through all tubules into the renal pelvis. He assumed that the muscular elements in the calical mucosa act like a pressure and suction pump, aiding in the transportation of urine through the renal parenchyma and the renal pelvis with its various recesses. He knew the physiologic narrowings of the renal calices, the pelvis, and ureters. Haebler, in 1922,

published observations on nervous elements in the renal pelvis. He found no nerve cells in the renal calices, while an abundance of vegetative sheathless nervous fibers could be observed, which, with their terminations, were found to approach the muscle fibers. He suspected nerve cells in the renal pelvis proper. The presence of these nervous elements in the calical and pelvic mucosa was considered responsible for the automatic tonus of the urinary passages and its adaptation to changing conditions; it was also considered related to the development of neuro-muscular diseases, like atony and hydronephrosis, without obstruction of the passage. I am informed that, at the University of Pennsylvania, a re-investigation of the muscular and nervous elements of the urinary passages has been recently conducted by Dr. Kam under the direction of Professor Batson. The results of this investigation, however, are not published as yet, although from personal communication of Dr. Batson it is learned that no important new structures were found.

Such a well-organized system of muscular tissue in the urinary passages must have the distinct function of contraction and relaxation, which is characteristic of muscle fibers. However, when one scans the text-books of physiology in regard to renal function, very little is to be learned about the renal pelvis, though the ureter is dealt with somewhat more generously. The classical work of Engelmann, published seventy-five years ago and frequently cited since, and papers of Sokoloff and Luchsinger, Lucas, Satani, Wislocki and O'Connor, Graves and Davidoff, Hryntschak, Gruber, Trattner, and others, all contain extensive and important information concerning the ureter under various experimental conditions, but the renal pelvis is entirely overlooked. Penfield states in a report concerning ureteral contractions, that the renal pelvis normally is the pacemaker for the transport of urine to the bladder, but that under abnormal conditions a new pacemaker may be established somewhere else in the

tract. Text-books of urology mention renal and ureteral peristalsis in very short paragraphs, stating that this action and spasm may at times lead to misinterpretation of pyelograms. A detailed analysis of the phenomenon, however, does not seem to exist.

It is surprising that in the literature as recently as 1931 a well co-ordinated function of all these muscular elements of the urinary passages was doubted and denied by certain authors. We found in the proceedings of the Viennese Society of Roentgenology that on June 2, 1931, K. Hutter stated: "Transportation of urine in the upper two-thirds of the urinary tract proceeds continually without distinct waves of contractions," and "various degrees of filling of the renal pelvis are caused by various degrees of diuresis rather than by peristaltic action." This statement was immediately opposed by Hryntschak, who undoubtedly knew renal and ureteral peristalsis quite well from personal experience. The first information concerning observed peristalsis of the renal pelvis was recorded by Wassink, who described observation of rhythmic peristaltic contractions of a surgically removed hydro-nephrotic renal pelvis, which persisted for quite a while following the extirpation. Haebler, in 1922, described the differences in the muscular elements of the renal pelvis in man and various mammals, and mentioned that he has repeatedly seen peristalsis of the renal pelvis and calices in man and animals. Westenhoefer, in 1922, reiterated his statement of 1914, remarking also that he personally informed Haebler and his teacher, Professor Ringleb, one year prior to Wassink's publication, about his conceptions of renal peristalsis. All observations of renal peristalsis recorded so far were obtained by inspection of surgically prepared specimens. Legueu, his co-workers, and followers advanced and to a certain degree systematized information concerning this function of the muscular elements by fluoroscopic study of the urinary passages, following the introduction of contrast



Case 4 (Fig. 2-D). Mr. St. K., L. I. *History*: Chronic osteomyelitis. *Roentgen diagnosis*: Chronic, non-destructive pyelonephritis.

Case 5 (Fig. 2-E). Miss F. M. *History*: See preceding series. Condition after clinical recovery from recurrent pyelonephritis. *Roentgen diagnosis*: Gradual appearance of renal lumina. Persisting upper ureteral stricture. Entirely inactive pelvis. L.

E., Feb. 24, 1932, five minutes after injection.

Case 6 (Fig. 2-F). Mr. R. D., L. I. *History*: Septicemia. Bilateral hemorrhagic pyelonephritis and cystitis. Death six months after pyelography. No autopsy. *Duration*: Eighteen months. *Organisms*: *Escherichia* (*B. Coli*). *Roentgen diagnosis*: Chronic, non-destructive pyelonephritis and ureteritis.

Case 1 (Fig. 2-A). Miss F. M. *History*: During recurrence of acute pyelonephritis. *Organisms*: *Escherichia* (*B. coli*). *Roentgen diagnosis*: Extremely spastic renal pelvis with reduced capacity (edema). Irregular alternating peristalsis. R. E., Feb. 24, 1932 (sides reversed).

Case 2 (Fig. 2-B). Mr. X. L. I. *History*: Acute pyelonephritis. *Duration*: A few days. *Roentgen diagnosis*: Anatomically normal marked functional inhibition: acute infection.

Case 3 (Fig. 2-C). Miss F. M. *History*: Acute bilateral pyelonephritis. Impacted calculus in right lower ureter. *Duration*: One week. *Escherichia* (*B. Coli*). *Roentgen diagnosis*: Upper ureteral stricture. Alternating peristalsis of somewhat spastic appearance. L. E., June 18, 1931, during recovery (sides reversed).

Explanation of abbreviations: Pyelography: E—Excretion; I—Instrumental; R—Right; L—Left.

media through ureteral catheters. Since his publications, dating back to 1922, various French, German, and American authors attempted to advance our knowledge concerning these functional phenomena. It is somewhat difficult to learn from their publications the exact meaning of their observations, and it is quite apparent that the technic employed—fluoroscopy supplemented by a few roentgenograms taken at intervals—is chiefly re-

sponsible for these difficulties. Most of these authors based their studies on the work and conclusions of Legueu, Fey, and Truchot, and no important observation has been recorded beyond those stated by these French authors in their book "La Pyeloscopy," published in 1927. With the analysis of our own observations we will have to refer to these important and valuable French publications. Two principal features characterize our own

studies and distinguish them from the work of the aforementioned observers:

- (1) We employ the serial-roentgenographic method in contrast to the fluoroscopic;
- (2) We use chiefly excretion pyelography with various media. Some instrumental pyelographic records were included, principally to illustrate differences from excretion pyelography.

A correct conception of existing renal lumina is not always gained from pyelographic images. Factors inherent to roentgenography of necessity introduce the following conditions which must be borne in mind if misconceptions are to be avoided: unidirectional projection; distortion; rotation; overlapping; lack of sharpness, etc. The information presented must always be regarded as relative in view of perpetual changes to which all living organs are subject. For instance, the factors of fluctuating body hydration and diuresis must be responsible for marked variations.

The illustrations used in connection with this paper were obtained in the following manner: Cinex-films were carefully traced under a reducing lens with a sharply pointed pencil; they were then printed on photographic paper, silhouettes being cut along the tracing lines which in turn were pasted on cardboard, faces reversed. Some series with delineation insufficient for correct tracing were reproduced photographically and are thus shown. Many series had to be omitted from consideration for technical reasons. The average series consisted of twenty individual pyelograms. Exposure times varied from one-half to one and one-half seconds, intervals averaging one-half to three-fourths seconds. A revolving Åkerlund diaphragm was employed routinely. Records were obtained with respiration arrested in various phases; usually, it was possible to secure from five to eight successive pyelograms without interruption for breathing.

A brief critical review of conditions incidental to the usual type of pyeloscopy or instrumental pyelography and prevailing with serial excretion pyelography as here

presented, is necessary in order to form a proper basis for the interpretation of our studies. For pyeloscopic purposes, as advocated by Legueu and his followers and for the usual instrumental pyelography, cystoscopy with introduction of ureteral catheters is necessary. One can hardly consider such instrumentation as physiologic, and the distress elicited gives sufficient evidence of the defense mechanism invoked. Eliminative efforts of the muscular elements of the urinary passages, stimulated to expulsive action against the foreign body which acts as a mechanical block, must be very strong in some instances, as even the relatively rigid ureteral catheters at times are transported distally over appreciable distances. In addition, the hypertensive solution which is injected into the urinary lumina, not only distends them beyond their normal or accustomed degree but undoubtedly also evokes a strong osmosis, depending in degree upon the concentration of the injected water soluble substance. Under such conditions one can hardly expect normal motor phenomena, and we trust that we can show you later on characteristic behavior of the renal passages, which we regard as the direct result of these procedures. Realizing these factors, which undoubtedly must influence the functional behavior of the muscular elements, we are basing this study chiefly on excretion pyelography. Various contrast media have been used as pyelognost, skiodan and different uroselectan preparations. Characteristically different effects of these preparations on the motor phenomena in the urinary tracts were not observed, but the newer preparations are better tolerated and produce better images. At present, we prefer neo-iopax and neo-skiodan. With these contrast media administered intravenously, we obtain our serial pyelograms, entirely avoiding instrumental or chemical interference with the urinary lumina. The only possible relatively unphysiologic effect might be the increased diuresis resulting from the injection of a hypertensive solution. However, this de-

gree of diuresis should not exceed physiologic limits and certainly occurs under various other influences (coffee, alcoholic beverages, etc.).

We repeatedly attempted fluoroscopic observations in combination with these excretion pyelographic procedures, but were disappointed quite regularly. The shadows obtained are relatively faint, even in roentgenograms of good quality, and do not lend themselves to proper fluoroscopic study. Therefore, we relied exclusively on the serial pyelographic method. This discourse should not be regarded as indicative of a hostile attitude toward pyeloscopy. We highly appreciate the work of Legueu and the efforts of our friends, Dr. H. L. Morris and Dr. Carl Weltman; however, we feel that we advance a little further toward the realization of our mutual ideal, namely, true roentgen cinematography. At present this method is hardly applicable to pyelography, as the high amounts of energy required for individual exposures soon would exceed the tolerance of the patient's tissues; there are, however, possibilities under consideration, which may eliminate these technical objections.

Series 1-B is reproduced now, because it illustrates unusually well the regular peristaltic cycles, which traverse the various renal segments. Particularly observe the upper calyx, infundibulum, and the pelvis proper. You will recognize these peristaltic cycles on review of the twelve successive images reproduced. This type of peristalsis is quite different from that seen during pyeloscopy after the usual routine. You will remember that Legueu and his followers unanimously describe an alternating type of peristalsis, during which contraction of the calices is accompanied by relaxation and distention of the pelvis, and *vice versa*. Here we have different phenomena. We notice a progressive, descending pro-peristalsis, starting in the periphery and continuing toward the ureter. (We do not regard this series as entirely normal. Clinically, the patient is just recovering from an acute

pyelonephritis with *Escherichia (coli)* cultured from the urine. It is observed that *complete* calical contractions do not occur, and that the formation of the ureteral bulb is somewhat indistinct. We consider these signs to be mild residual evidence of the previous infection, but, in view of the otherwise excellent functional behavior, we venture to give the patient a good prognosis for complete recovery.) The beautiful regularity of the peristaltic rhythm is not apparent in all following series, because images were not always timed as ideally as was incidentally obtained here. Illustration 1-C, in contrast, shows the alternating type of peristalsis, which is observed regularly with instrumental serial pyelography or pyeloscopy. Clinically, this patient's kidney had to be regarded as entirely normal. A review of the images reproduced generally shows larger lumina, which during the procedure gradually diminishes in size. Irregular peristaltic waves arise here and there in the renal pelvis, and finally you see alternating contractions, particularly of the middle and lower calices and the pelvis. The ureteral bulb is well formed. Ureteral kinks just below the uretero-pelvic junction seen in some images are merely the result of inspiratory shifting. We hope that the essential differences between these two types of motor phenomena, the normal physiologic, progressive, descending pro-peristalsis and the alternating type of peristalsis, are convincing. The latter, to which we will refer again later on, we believe to be an obstructive type of peristalsis, or it may be termed a disturbance of normal gradients. At times, we have designated it as renal vomiting. Both kidneys illustrated by series 1-D and 1-A are considered clinically normal, though a cystitis was observed at one time. In illustration 1-D, complete calical contractions in various segments may be observed and apparent refilling from the periphery. No two, of the eighteen images of illustration 1-A mentioned above, are alike. This renal pelvis undoubtedly was in a state of great activity. The sequence of the

Case 1 (Fig. 3-A). Mrs. De L., R. I. *History*: Bilateral pyelonephritis; cystitis. *Duration*: Uncertain. *Organisms*: Not recorded. *Roentgen diagnosis*: Chronic—partly destructive (?) pyelonephritis; ureteritis with strictures. Observe complete rigidity of renal pelvis and upper ureteral segment.

Case 2 (Fig. 3-B). L. I. *History*: Condition after recovery from acute low ureteral obstruction—one week before this study. *Duration*: About six months. *Organisms*: Not recorded. *Roentgen diagnosis*: Over-distended, partly extrarenal pelvis. Development of powerful alternating peristalsis.

Case 3 (Fig. 3-C). Mrs. S., R. I. *History*: Acute pyelonephritis. *Duration*: Very short, according to patient. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: Rather chronic destructive pyelonephritis. (Tubercle bacilli not ruled out.) Reproduced films 1, 10, and 20 of a series of twenty. Apparent motility is simulated by gradual migration of NaI into recesses of pelvis. No peristalsis whatsoever.

Case 4 (Fig. 3-D). M. S., R. I. *History*: Recurrent pyelonephritis; ptosis; palpable kidney. *Duration*: Uncertain. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: Observation during quiet period: over-distention. Overflow emptying, with weak, ineffective, alternating peristalsis.

Case 5 (Fig. 3-E). Mr. T. P., L. I. *History*: Calculus pyonephrosis. *Duration*: Uncertain; of long standing. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: Destructive pyonephrosis with calculus. Only first and twentieth images of series reproduced, as no motion could be detected.

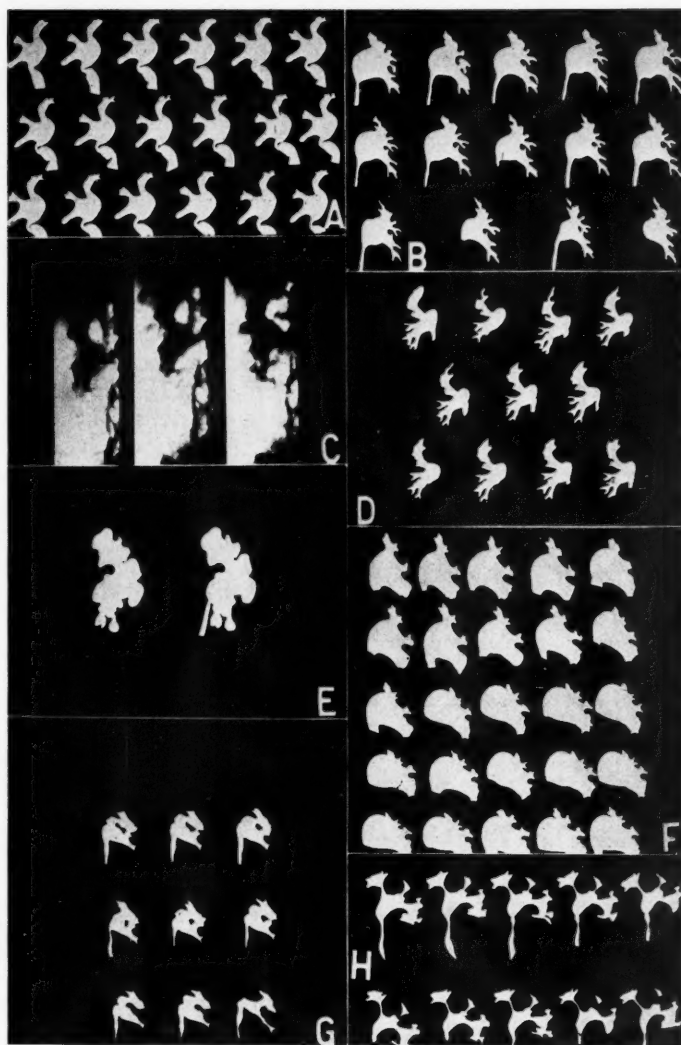
Case 6 (Fig. 3-F). Mr. L., R. I. *History*: Infected hydronephrosis, ureteritis, cystitis. *Duration*: Ten years. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: Chronic,

non-destructive pyelonephritis. Note remaining competency of ureteral sphincter, and activity of minor calices.

Case 7 (Fig. 3-G). Mrs. D. *History*: Repeated laparotomies during 14 years, at various hospitals. She had appendicitis, adhesions, pus in abdomen, oophoritis and salpingitis, gastric ulcer, etc. The patient was admitted in October, 1929, and in December, 1929, she suffered with acute retention cystitis. Urologic examination was negative. *Roentgen diagnosis*: (Renal

pelvis) mild distention of pelvis and calices; inability at complete segmental contractions; good progressive properistalsis: state after recovery from acute pyelonephritis of short duration. Images show phases of two peristaltic cycles.

Case 8 (Fig. 3-H). Mr. G. R., R. I. *History*: Mild chronic pyelonephritis, under treatment. *Duration*: From six to eight months. *Organisms*: *Escherichia (B. Coli)*. *Roentgen diagnosis*: Over-distention; overflow emptying. Very limited activity. Cicatrization in the upper infundibulum.



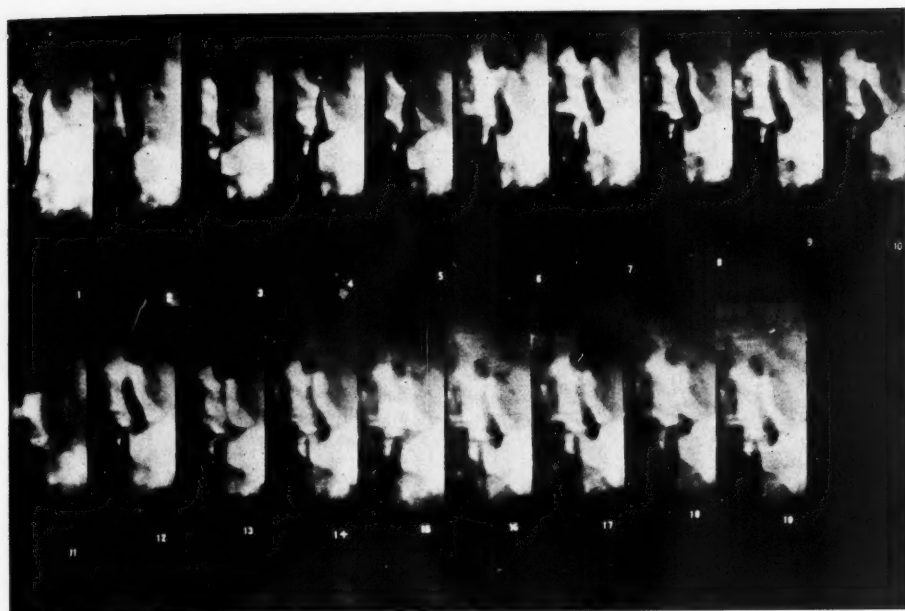
rhythm is not always as well apparent as in Series 1-B, but the type of contractions can be studied quite readily. There is no alternation between calices and pelvis proper. A survey of these eighteen images must bring vividly to our mind the possibilities of mistaken diagnoses, arising from too few pyelographic records taken at random. Every one of these eighteen images, of course, must be regarded as entirely normal, presenting merely various phases of peristaltic cycles, and *temporary blunting* of calices does not signify infection.

Series 1-E shows the first deviation from normal function. Following recent extirpation of the opposite kidney, it may be noted that this kidney is carrying an excess load. The size of the renal lumina and the pronounced activity, showing a tendency toward alternating contractions, are regarded as the results of loss of balance between excretory load and carrying ability, or incomplete adaptation to new conditions. We want to draw particular attention to the fact that complete contractions of various calical segments occur; this we consider to be an important point for the interpretation of the absence of chronic infection.

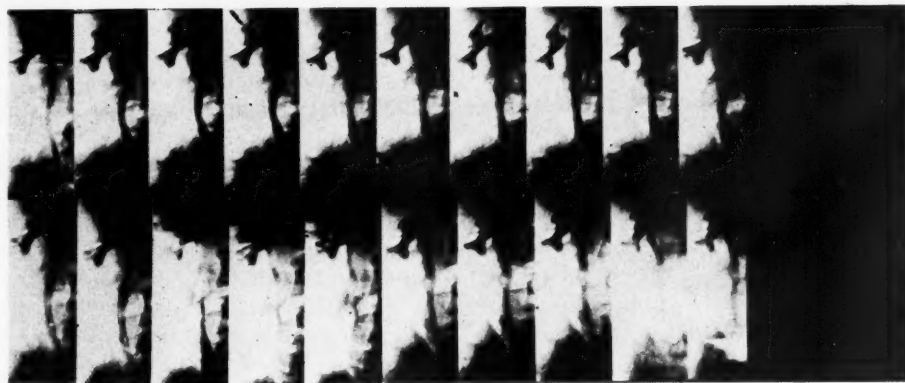
A remark concerning the physiologic content, capacity, and so-called emptying time of the renal pelvis will be justified in this connection. The five series presented show the renal pelvis more or less filled. As seen with excretion pyelograms, it is never entirely empty, but its content and capacity may vary widely under fluctuating intrinsic and extrinsic conditions. Content and capacity are not synonymous terms; the latter depends on the degree of elasticity, the former chiefly on the tonus of the mucosa. The normal renal pelvis undoubtedly can adapt itself quite readily to various conditions of body hydration, diuresis, and a certain impairment of evacuation, as it occurs physiologically with increasing filling of the bladder. Information about factors influencing the pelvic tonus is lacking. "Emptying time" must be considered a logical error and could only be con-

ceived under conditions of instrumental pyelography and pyeloscopy with foreign material introduced artificially. The question is often asked, as to how the renal pelvis fills under normal conditions. We have reason to assume that such filling takes place rhythmically from the periphery, under the influence of the milking action of the so-called calical sphincters, which seem to have a stripping effect upon the pyramids. If this conception is correct, the refilling does not consist of a continuous even inflow from all renal segments, but proceeds segmentally from the various calices with their individual contractions. One may speculate that these contractions in turn are elicited by filling and distention of the renal tubules.

At this point it seems worth while to contemplate briefly on the intrinsic mechanism which is responsible for the motor phenomena demonstrated above. We cannot refer to any experimental work in this connection, as we did not find a record of such concerning the renal pelvis. The effect of decapsulation of the kidney on the motor function of the renal pelvis is not known; it might possibly produce alteration similar to that seen in the bowel following the cutting of the vagi and splanchnics, and also degeneration of Auerbach's and Meissner's plexus. The very extensive investigation of the gut, so well reviewed in Alvarez' book, "The Mechanics of the Digestive Tract," must of necessity elicit the thought of analogies, present in the urinary tract. But unfortunately one cannot regard the mystery of intestinal peristalsis as solved in spite of the overwhelming wealth of work. There remain uncertainties, contradictions of observations, interpretations and deductions, and many purely philosophical theories, not based on observation of facts. A few important points, however, should be stressed: Bayliss and Starling's law of the intestine, or the so-called myenteric reflex, cannot be upheld in the light of recent knowledge, though it dominates physiologic text-books. Small-intestinal muscle freed from all nerve plexus will continue



A



B

Case 1 (Fig. 4-A). *Pelvic peri-ureteritis*, with pronounced pro- and anti-peristalsis in upper two-thirds of ureter. The pelvic ureteral segment (one-third) does not distend to accommodate and pass on amounts of urine brought down from the renal pelvis (sequela to pelvic inflammatory disease).

Case 2 (Fig. 4-B). *Pelvic peri-ureteritis*. Anti-peristalsis of the ureter is less pronounced, segmentation less evident, but regurgitation into the renal pelvis cannot be denied.

to contract under suitable conditions; also cultivated, undoubtedly nerve-free smooth muscle cells will contract rhythmically. Alvarez and Mahoney made the following statement: "Consequently there is no need for looking beyond the muscle for the source of the rhythm," and the conception that Auerbach's or Meissner's plexus was the source of intestinal peristalsis has to be abandoned; yet on the

other hand, vagus and sympathicus exert an undeniable controlling influence on intestinal function.

Alvarez has formed the conception of gradients of peristalsis and assumes gradients of rhythmicity, irritability, latent period, tone, muscular strength, and metabolic rate. He summarizes his conceptions as follows: "If I were asked to formulate a law for the intestine, I would say

that stimulation of any point leads to the holding back of material coming down from above and the hurrying onward of material already below." He also states that factors altering the gradients include traumatization, inflammation, ulceration, and may be localized in (1) the mucous membrane, (2) the muscle lining the tract, (3) the serous coat, (4) the neighboring organs, and (5) possibly in the nervous plexus. He expressed in a private letter his opinion concerning conditions of transportation of urine, as follows: "If I remember correctly [from your exhibit] the waves that go down the ureter begin up in the calices of the kidney. From analogy with conditions in the digestive tract this is just what I would expect. . . . Anything which will raise the irritability or metabolic rate of the tissues along the tract, even if it does not produce mechanical obstruction, is likely to block or to reverse waves and to produce back pressure and even complete obstruction. . . . I have suggested in one of my papers that the dilated ureter and kidney pelvis so commonly seen in pregnancy, can be due to the same dynamic reversal that we get in the bowel. Nervous stimulation which might tend to raise the irritability of the lower end of the ureter might also produce back pressure."

We have not at our disposal a physiologic laboratory, nor the time and means to conduct detailed, purely physiologic experimentation. From a practical clinical viewpoint, and our own experimentation, we can readily accept Alvarez' conceptions. Their consideration is well worth while in the evaluation of all pyelographic investigations. The alternating type of pyelo-peristalsis, shown above in Figures 1-C and 1-E might well be termed a decided disturbance of peristaltic gradients, if one wants to follow Alvarez' train of thought. We also want to mention in this connection that we have seen a prolonged, temporary inhibition of renal motility as the result of nausea and headaches.

Having thus demonstrated what we be-

lieve to be normal peristalsis of the renal pelvis under physiologic conditions, we now shall attempt to describe and illustrate changes in this mechanism, which take place as a result of infection in various stages. A pyelonephritis in its acute stage is characterized by edema and increasing round cell infiltration. Such pathology is rendered manifest in excretion pyelograms by the apparent persistent discontinuity of the renal lumina (for which perhaps spasticity might also be in part responsible). Figure 2-A demonstrates this point very well, showing also a relative reduction in size of the entire renal pelvis. From this series it is also apparent, that instead of the normal, progressive, descending pro-peristalsis the alternating type of peristalsis as seen with instrumental pyeloscopy and pyelography is present. Undoubtedly there is also an appreciable degree of irritation which is well expressed by the arrhythmic violent mass contraction.

Figures 2-C and 2-E show the opposite kidney of the same patient in somewhat different phases of the infection. In 2-C the renal lumina are relatively small—as the result of edema present. Peristalsis is of the alternating type, arrhythmic and somewhat reduced in force. Most calical contractions are incomplete. There exists an upper ureteral stricture, which is regarded as partly responsible for the change to the alternating type of peristalsis. The same kidney, after clinical recovery from this infection is shown in Series 2-E. The first images reproduced here demonstrate the gradual appearance of opacity in the renal lumina shortly after injection of neo-iopax. The succeeding images show increasing distention but hardly any peristaltic activity: we designated such inactive emptying as overflow emptying. We feel inclined to assume that rather severe damage to the muscular apparatus of this urinary tract developed with the active pyelonephritis.

As edema and round-cell infiltration increase, the musculature is more and more inhibited and a study of its function during an acute pyelonephritis of a few days' dura-

tion shows more or less elimination of peristalsis. This is illustrated in Series 2-B. Each of the six images reproduced appears to be anatomically normal. A review of the series, however, which we could have prolonged at will, shows rather marked paralysis. We consider this interference with the active transportation of urine to be an important factor in the development of hydro- and pyo-nephroses. We believe that this inhibition of peristalsis starts a vicious circle, leading to increasing distension and stasis, increasing round-cell infiltration, pressure atrophy, and finally, destruction of mucosal and parenchymal elements.

Consequently, observation on more or less chronically infected renal pelves will show increasing distention of the lumina and increasing inactivation of the transportation tract on organic basis. With artificial re-establishment of drainage, one may expect to detect cicatrization and sclerosis.

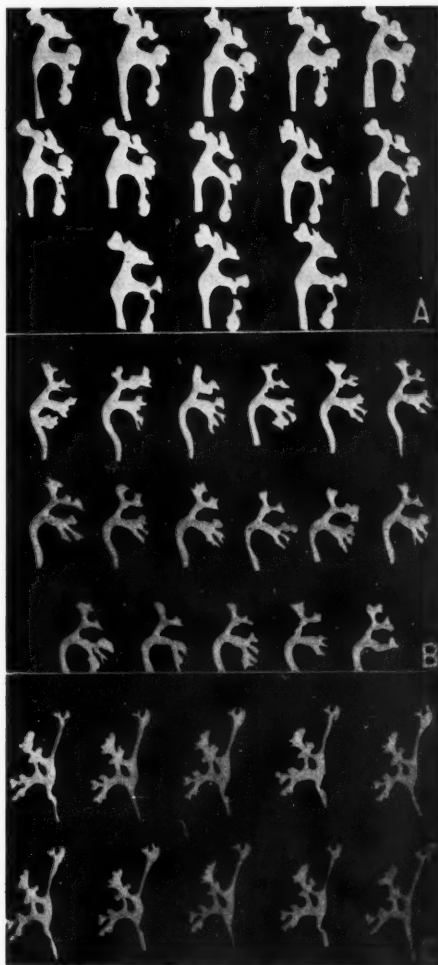
The succeeding illustrations demonstrate anatomic and functional conditions of renal pelves in various stages of infection. Few remarks are necessary in addition to the legends.

Figure 2-D shows a pyelonephritis of somewhat longer duration: anatomic changes are quite apparent. Concerning the physiologic behavior, we want to point out the inability of the calices to expel their contents completely; furthermore, reversal to the alternating type of peristalsis with rather weak pelvic contractions.

Figure 2-F is a series of instrumental pyelograms, beginning with relative over-distention of the renal pelvis, which is gradually corrected by overflow. Afterward a pronounced immobilization of the renal lumina is quite apparent.

Figure 3-A shows that immobilization in this stage is complete. We feel inclined to assume that the muscle coat of this renal pelvis underwent either destruction or atrophy to an appreciable extent.

Figure 3-C shows a chronic, destructive pyelonephritis, with complete immobili-



Case 1 (Fig. 5-A). Mrs. Z., I. L. History: Essential hematuria. Duration: Five years. Organisms: *Escherichia (B. Coli)*. Roentgen diagnosis: Chronic pyelonephritis and ureteritis. Stricture in lower infundibulum.

Case 2 (Fig. 5-B). Mr. T. S., L. I. History: Colitis. Chronic pelvic adnexitis—prostate, seminal vesicles. No renal symptoms. Duration: Uncertain. Organisms: *Escherichia (B. Coli)*. Roentgen diagnosis: Capacity reduced (?). Alternating peristalsis. Widely patent uretero-pelvic junction. Chronic cicatrizing pyelonephritis.

Case 3 (Fig. 5-C). Mrs. S. S., R. I. History: Three months after nephropexy for pyelectasis, ptosis, chronic non-responsive infection. Clinically cured. Duration: Quite chronic. Organisms: *Escherichia (B. Coli)*. Roentgen diagnosis: Rigid, sclerosed renal pelvis.

zation of the renal pelvis. Gradual diffusion of contrast medium into various recesses of the pelvis should not be confused

with peristaltic efforts (only three of the twenty records were reproduced).

Figure 3-E shows a pronounced pyonephrosis. No sign of muscular activity is preserved (only two of twenty records were reproduced as no other changes were apparent).

Not all series coming to observation are as readily analyzed and correlated as those presented so far. The severity of a pyelonephritic infection may vary as may also the reaction between the infecting agent and the host. Each subject presents its individual problem and Figures 3-G B D F H and 4-A and 4-B demonstrate some of our interpretations with interesting physiologic observations. In addition to the legend, we want to point out that from the functional behavior of the kidneys a prognosis of complete anatomic and functional recovery was given to the patients of Series 3-G and 3-B, while Series 3-D, 3-F, and 3-H suggest various degrees of permanent irreversible damage to the renal pelvis, or its calices, respectively, with sufficient functional ability left to justify conservative management. Series 4-A and 4-B are introduced as examples of low ureteral stricture produced by peri-ureteritis; the effects of this inflammatory process surrounding and probably also invading the lower ureters are principally identical in both cases but different in severity and duration. It should be emphasized that the diseased portions of the ureters are the lowest pelvic segments (not so well included in Series 4-B) which anatomically appear rather normal but are in reality rigid, devoid of elasticity and motility. The upper segments, which are so markedly distended, are to be regarded as functionally competent. The distention and the pronounced peri- and katalstalsis, apparent in the upper segments, represents a compensatory attempt at correction of the deficiencies below. Series 5-A, 5-B, and 5-C are reproduced to illustrate different degrees of cicatrization and sclerosis in the renal pelvis.

Some time ago we attempted to tabulate the roentgen symptomatology of infected

urinary passages for the Chapter on "Renal and Perirenal Infections" by Dr. H. W. Plaggenmeyer in the *Cyclopedia of Medicine* (Piersol). This table and four additional ones are reproduced as the shortest possible résumé of our conceptions of pyelonephritis, which is admissible in this paper. We are well aware of the deficiencies of these extremely abstract records.

Finally, it is our desire to mention analogies and characteristic differences in the functional behavior of other hollow viscera. This entails a repetition of statements made in previous publications, which, however, are not yet commonly known and accepted.

Bronchial peristalsis is timed to the expiratory phase of the respiratory cycle, while a relaxation of all bronchial structures takes place during inspiration. No similar coincident timing of renal or intestinal peristalsis is known, but, under normal conditions, bronchial, intestinal, and renal peristalsis are of a rhythmic, progressive, propulsive type, alternating with periods of "diastole."

A relative insufficiency of bronchial musculature was demonstrated in emphysema, apparently as an incompetency of the alveolar sphincters. Such dysfunction distinctly reduces the efficiency of bronchial peristalsis, preventing complete pulmonary ventilation. Certain disabilities of renal pelvis, including some types of mild hydronephroses, may be cited as analogous conditions: mild intestinal atony can be considered as an equivalent dysfunction.

Analogies between infected bronchiectasis, pyonephrosis, and pyosalpinx require no further explanation; distention of the viscus, infiltration, and destruction of its wall, with resulting immobilization on organic basis, are the characteristic features of such pathology. The analogy to vomiting may be found in the alternating type of renal peristalsis.

In two patients with bronchial asthma, we observed marked local and general spasticity of the bronchi. Similar condi-

TABLE I.—ROENTGEN SYMPTOMATOLOGY OF INFECTED URINARY PASSAGES

		Roentgen anatomy of the			Renal Pelvis and Calices			Roentgen physiology			Additional information from excretion-pyelography			
Type of infection	Renal pelvis and calices	Ureter	Capacity	Peristalsis	Emptying type	Ureteral peristalsis	Appearance time	Concentration	General demonstrability	Recovery				
1 Absent	One of the normal variations	Shallow S-curve often with inspiratory double kink	Normal (3-8 c.c.)	Well-defined, rhythmic peristalsis	Active, rhythmic	Fast peristalsis frequently good expulsion bulbs	Short, less than 5 min.	Good, early	Inconsistent, with few films at times unsatisfactory					
2 Acute, general	Not demonstrably altered		Reduced due to mucosal edema	Inhibited (paralyzed due to edema and early infectious infiltration)	Inactive, overflow	Lagging or spastic expulsion bulb	Short	Good, early	Unsatisfactory	To normal possible without anatomic or functional deficiencies				
3 Subacute, subchronic	Moderately distended	Early dilatation	Moderately increased	Weak, inefficient	Mixed: partly active, partly overflow, arrhythmic	Sluggish, no expulsion bulb	Not impaired	Good	Good throughout	Possible: functional deficiencies: loss of expulsion bulb, occasional stricture, potential hydronephrosis and stone formers				
4 Chronic, non-destructive	Marked distention, pressure on parenchyma	Dilatation	Markedly increased	Absent	Chiefly overflow, occasional attempts at contractions, arrhythmic	Poorly defined peristaltic contractions	Delayed	Reduced (?)	Fair	Accompanied by catarrh, sclerosis, overflow emptying, and potentialities of No. 3				
5 Chronic, destructive	Excavation of parenchyma	Irregular dilatation	Large	Absent	Overflow and by external forces	Absent	Much delayed, depending on condition of parenchymal residue	Often poor, inefficient	Poor	Unlikely, though remissions and temporary improvement can be accomplished				
6 Chronic peristalsis and ureteral stricture	Degree of distention depends on location of stricture	Involved part narrow, dilatation above, receding proximally	Increased	Enforced pro-and anti-peristalsis	Very active	Involved part rigid, obstructive and antiperistalsis proximally	Short	Good, early	Good above obstruction and in bladder	Subjective and objective improvement following stricture and resorption of infiltrates: functional deficiencies will persist in possibly lessened degree				

Remarks:

- Effects of acute peri-ureteral tract infection have not been studied as yet.
- From several observations we feel inclined to conclude that neurotrophic disturbances (atony-paralysis) may in some instances produce changes much resembling those incident to infection.
- Effects of primarily localized, but from the onset invading and destructive infections—tuberculosis, actinomycosis, etc.—may be logically deduced from the above table according to location, extent, and duration. Often a non-specific general infection is found superimposed, complicating the interpretation of roentgen studies.

tions are well known in the gut—cardio-spasm, pylorospasm, intestinal intussusception of infants, etc.—and also occur in the urinary tracts—hydronephrosis and hydroureter of pregnancy due to establishment of a new and more powerful pace-maker than the renal pelvis in the lower ureter, spasticity of renal pelvis during onset of pyelitis, and retention-cystitis.

However, the mistiming of bronchial peristalsis seen in one of these asthmatic patients—relaxation on expiration, contraction on inspiration—is a unique record, perhaps only comparable to certain cardiac dysfunctions. The vascular system, when investigated some day by new methods, will yield more analogies, which now may only be the subject of theorizing speculation. New contrast media may open here possibilities for fascinating diagnostic and prognostic, if not also therapeutic endeavor.

SUMMARY

- (1) A rhythmic, progressive, descend-

ing, pro-peristalsis of the normal renal pelvis is demonstrated by fast serial pyelography (Cinex-camera).

(2) This is different from the "alternating" type of renal peristalsis described by Legueu, Fey, and Truchot, which is considered to be the result of unphysiologic or pathologic conditions, but seems to occur regularly with any instrumental or infectious disturbance in the urinary tracts.

(3) Pyelonephritis produces a characteristic alteration of pyelo-peristalsis. This ranges from "alternating" peristalsis over inhibition to complete organic immobilization, depending on type, virulence, duration, location of the infection and the reaction between the infecting agent and the infected host.

(4) The characteristic functional effect of low pelvic periureteritis is shown with pro- and anti-peristalsis in the upper ureteral segments.

(5) Tabulation concerning pyelonephritis.

INFECTIONS OF THE URINARY SYSTEM

TABLE II.—CLASSIFICATION AND CLINICAL-PATHOLOGICAL TERMINOLOGY

<p>(A) Primarily parenchymal renal infection (descending):</p> <p>Bacterial or infectious nephritis, with cortical and medullary } involvement</p> <p>Leading to formation of: Renal carbuncle Multiple renal abscesses Septic renal infarcts</p>	<p>Pyelonephritis acute and chronic</p>	<p>(B) Primarily mucosal urinary tract infection: (Nephro) pyelitis Leading to development of: Pyonephrosis Hydronephrosis Ureteritis Leading to development of: Pyoureter Hydroureter Cystitis Urethritis</p>
<p>(C) Infections primarily involving tissues adjacent to the urinary tracts: (C) Infections primarily involving tissues adjacent to the urinary tracts: Peri-nephritis and peri-nephric abscess; peri-ureteritis; pelvic adnexitis; peri-cystitis; peri-urethritis.</p>		

TABLE III.—SOURCES AND ROUTES OF URINARY TRACT INFECTIONS

Sources	Routes
<p>A. Endogenous (infectious foci) most common in the:</p> <p>(1) Alimentary canal, including masticatory apparatus;</p> <p>(2) Respiratory passages including paranasal sinuses and pharynx;</p> <p>(3) Skin (<i>i.e.</i>, acne and furunculosis).</p> <p>B. Exogenous—most important:</p> <p>(1) Cohabitation;</p> <p>(2) Trauma, including instrumentation.</p>	<p>A. (1) Blood stream (2) Lymphatic system (doubtful) (3) Direct extension</p> <p>B. (1) Urogenital passages (ascending) in connection with Vesico-ureteral reflux Pyelo-venous back-flow(?) Tubulo-venous contact</p> <p>(2) Path of implantation in connection with A and B(1)</p>

(6) Analogies in the physiologic behavior of various hollow viscera are briefly pointed out.

TABLE IV.—PATHOGENIC ORGANISMS (INFECTING AGENTS RESPONSIBLE FOR URINARY TRACT INFECTIONS)

- A. Specific strains:
 - Neisseria gonorrhea*, *mycobacterium tuberculosis*, *hyphomycetes* (pathogenic moulds), *blastomycetes* (pathogenic yeasts), *trichobacteria* (actinomyces, etc.), *treponema pallidum*.
- B. Aspecific strains (frequently mixed or possibly admixed to specific strains):
 - Escherichia (coli)*, *ebertella* (typhoid), *salmonella* (paratyphoid) groups
 - Staphylococcus and streptococcus groups
 - Escherichia* group causes 80 per cent of all these infections. Recognition of bacterial mutation important.

TABLE V.—COMMON FACTORS PREDISPOSING TO URINARY TRACT INFECTIONS

- (A) Mechanical factors
 1. Congenital malformations
 2. Acquired deformations (*i.e.*, bladder-neck obstruction, stricture, etc.)
 3. Malpositions, congenital or acquired
 4. Non-physiologic contents (*i.e.*, blood, concretions, foreign bodies)
- (B) Neurotrophic disturbances
(Paralysis-atony)
- (C) Pregnancy.

TECHNICAL NOTES CONCERNING THE ILLUSTRATIONS

The original series roentgenograms were obtained with the Cinex camera. Exposures ranged from one-half to one and one-half seconds. Intervals between exposures about one-half second for series of several exposures. Åkerlund diaphragm employed routinely. Patients in recumbent position. Respiration arrested in various phases.

Reproductions shown are contact prints, wherever insufficient delineation of shadows prevented correct tracing (6 series).

The other series were traced with pointed pencil under reducing lens, printed, silhouetted along tracing line and mounted reversed.

Many series had to be omitted for technical reasons. Acknowledgment is made to Dr. C. F. Hirshfeld and Dr. R. F. James for their assistance.

REFERENCES

1. ALVAREZ: The Mechanics of the Digestive Tract, second ed., P. B. Hoeber, New York, 1928.
2. ALVAREZ and FLETCHER: Jour. Pharmacol. and Exper. Therap., 1917-18, **10**, 365-377.
3. ALVAREZ and STARKWEATHER: Am. Jour. Physiol., 1918, **46**, 186-208.
4. ALVAREZ and MAHONEY: Am. Jour. Physiol., 1922, **59**, 421-430.
5. ALVAREZ: Am. Jour. Physiol., 1924, **49**, 229-247.
6. ALVAREZ and HOSOI, KIVOSHI: Am. Jour. Physiol., 1929, **89**, 182-186.
7. IDEM: Am. Jour. Physiol., 1929, **89**, 187-200.
8. IDEM: Am. Jour. Physiol., 1929, **89**, 201-212.
9. IDEM: Am. Jour. Obst. and Gynec., 1930, **19**, 2-12.
10. IDEM: Am. Jour. Surg., new series, 1929, **6**, 569-578.
11. ALVAREZ: Am. Jour. Physiol., 1929, **88**, 650-662.
12. ARAI: Arch. f. exper. Path. u. Pharmacol., 1922, **94**, 149-189.
13. ASCANIO and ALVAREZ: Am. Jour. Physiol., 1929, **90**, 607-610.
14. IDEM: Am. Jour. Physiol., 1929, **90**, 611-616.
15. BUSSE: Verhandl. d. deutsch. path. Gesellsch., 1904, **1**, 65.
16. COLE: Am. Jour. Surg., 1925, **39**, 107, 108.
17. CROSS: Jour. Urol., July, 1926, p. 37.
18. CRABTREE: Surg., Gynec. and Obst., December, 1922, p. 733.
19. DISSE: Handbuch d. Anat. d. Menschen von v. Bardeleben, Part 1, 7, 92.
20. EISENDRAH and ROLNICK: Textbook of Urology, second ed., J. B. Lippincott Co., Philadelphia and London, 1930.
21. ENGELMANN: Arch. f. d. ges. Physiol., 1869, **2**, 243-293.
22. EVANS: Starling's Principles of Human Physiology, fifth ed., Churchill, London, 1930.
23. FEY, TRUCHOT, and DOSSOT: Arch. Urolog. de la Clinique de Necker, July, 1925, **5**, 1-43.
24. FEY, BERNARD: Arch. Urolog. de la Clinique de Necker, April, 1926, **5**, 93-150.
25. GRAVES and DAVIDOFF: Jour. Urol., 1923, **10**, 185-231.
26. GRUBER: Proc. Soc. Exper. Biol. and Med., 1928, **25**, 329-331.
27. GUNN and UNDERHILL: Quart. Jour. Physiol., 1914, **8**, 275-296.
28. HAEBLER: Ztschr. f. Urol., 1922, **16**, 145.
29. HAEBLER: Ztschr. f. Urol., 1922, **16**, 377.
30. HAGNER: Jour. Urol., April, 1921, 388.
31. HEDBLOM and CANNON: Am. Jour. Med. Sci., 1909, **138**, 504-521.
32. HENLE: Handbuch d. syst. Anat. d. Menschen, 1866, **2**, 287-319.
33. HOWELL: A Textbook of Physiology. W. B. Saunders, Philadelphia and London, 1930.
34. HOTZ: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1909, **20**, 257-318.
35. HRYNTSCHAK: Fortschr. a. d. Geb. d. Röntgenstrahlen, **44**, 256.
36. IDEM: Arch. f. d. ges. Physiol., 1925, **209**, 542-561.
37. and 38. HUNNER: Surg., Gynec. and Obst., November, 1926, **43**, 615-626.
39. HUTTER: Proc. Wiener Gesellsch. f. Röntgenkunde. June 2, 1931, Fortschr. a. d. Geb. d. Röntgenstrahlen, **44**, 255.
40. JARRE, H. A.: The Cinex Camera. Grace Hosp. Bull., July, 1929, **13**, 3-14.
41. JARRE, H. A., and HUDSON, WILLIAM A.: Cinex Camera Studies of the Tracheo-bronchial Tree. Grace Hosp. Bull., July, 1929, **13**, 15-34.
42. IDEM: Cinex Camera Studies of the Tracheo-bronchial Tree. Arch. Surg., December, 1929, **19**, 1236-1244.
43. IDEM: Functional Studies of the Tracheo-bronchial Tree with the Aid of the Cinex Camera. Grace Hosp. Bull., October, 1929, **13**, 1-12.
44. IDEM: Functional Studies of the Tracheo-bronchial Tree with the Aid of the Cinex Camera. Brit. Jour. Radiol., December, 1929, **2**, 523-533.
45. JARRE, H. A.: The Cinex Camera. Am. Jour. Roentgenol. and Rad. Ther., November, 1930, **24**, 575-577.

46. JARRE, H. A., and CUMMING, ROBERT E.: Cinex Camera Studies on the Urinary Tract: A New Method of Functional Investigation. *Jour. Urol.*, October, 1930, **24**, 423-431.
47. JARRE, H. A., and HUDSON, WILLIAM A.: Étude fonctionnelle de l'arbre trachéo-bronchique à l'aide de l'appareil Cinex. *Bull. et mém. Soc. méd. d. hôp. de Paris*, November, 1929, **53**, 1236-1239.
48. JARRE, H. A.: Roentgenologic Studies on Physiologic Motor Phenomena. *RADIOLOGY*, September, 1930, **15**, 377.
49. IDEM: Roentgenphysiologische Studien. *Zentralbl. f. Chir.*, February, 1931, **58**, 526-532.
50. JARRE, H. A., and CUMMING, ROBERT E.: Roentgen-physiologic Studies on Pyelonephritis. In press.
51. JARRE, H. A.: Chapter XI, "Science of Radiology." Edited by Otto Glasser. C. C. Thomas, 1933.
52. JARRE, H. A., and JAMES, R. F.: Is Transformation of Therapeutically Ineffective, Penetrating Roentgen Energy into Biologically Effective Absorbable Radiation Possible? In press.
53. LEGUEU: *Paris*, 1922, **2**, 23.
54. LEGUEU, FEY, and TRUCHOT: *Soc. franç. d'Urologie*, November, 1924.
55. IDEM: *Presse méd.*, May, 1926, **26**, 657.
56. IDEM: *La pyeloscopie*, Paris, 1927.
57. LEWIS, M. R., and LEWIS, W. H.: *Am. Jour. Physiol.*, 1917, **44**, 67-74.
58. LOWER and NICHOLS: Roentgenographic Studies of the Urinary System. C. V. Mosby Co., St. Louis, 1933.
59. LUCAS: *Am. Jour. Physiol.*, 1906, **17**, 392-407.
60. MAGNUS: *Arch. f. d. ges. Physiol.*, 1904, **102**, 123-151.
61. IDEM: *Arch. f. d. ges. Physiol.*, 1904, **102**, 349-363.
62. MARKOWITZ and CAMPBELL: *Am. Jour. Physiol.*, 1927, **81**, 101-106.
63. MARTINEZ, GONZALES: *Urol. and Cutan. Rev.*, 1927, **31**, 286.
64. MATTES: *South. Med. Jour.*, 1927, **22**, 897.
65. MUSCHAT: *Jour. Urol.*, November, 1926, 351.
66. PENFIELD: *Am. Jour. Med. Sci.*, 1920, **109**, 36-46.
67. PLAGGEMEYER: Renal and Perirenal Infections. *Cyclopedia of Medicine (Piersol)*, 1933, **7**, 951-967.
68. SATANI: *Am. Jour. Physiol.*, 1919, pp. 474-495.
69. SOKOLOFF and LUCHSINGER: *Arch. f. d. ges. Physiol.*, 1881, **26**, 464-469.
70. TRATTNER, H. R.: Graphic Registration of the Function of the Human Ureter with Hydrophoragraph; Considerations in Physiology and Pathologic Physiology of the Ureter. *Jour. Urol.*, July, 1932, **28**, 1-33.
71. IDEM: A Method for Recording Contractions of the Intact Human Ureter. *Jour. Urol.*, 1924, **11**, 447.
72. IDEM: Ureteral Activity in Some Pathologic Conditions. *Arch. Surg.*, 1928, **17**, 968.
73. WRIGHT, HERBERT B., and BARLOW, O. W.: An Experimental Study of the Action of Sodium Iodide on Excised and Intact Ureters of Dogs. *Jour. Urol.*, 1930, **23**, 441.
74. SOLLMANN, T., TRATTNER, H. R., *et al.*: Composite Cinema Records, Showing Simultaneously the Peristaltic Activity of an Excised Organ and the Kymographic Record of Its Activity; as Applied to the Dog's Ureter and Rabbit's Intestine. *Arch. Intnat. de pharmacodyn et de therap.*, 1930, **38**, 292.
75. TRATTNER, H. R.: Recording of Spinal Fluid Pressure with the Hydrophoragraph. *Jour. Am. Med. Assn.*, 1932, **98**, 1081.
76. WASSINK: *Nederl. tijdschr. v. geneesk.*, 1921, **29**.
77. WESTENHOEFER: *Berl. Klinik*, 1914, p. 469.
78. IDEM: *Ztschr. f. Urol.*, **17**, 5.
79. WISLOCKI and O'CONNOR: Experimental Observations upon the Ureters, with Special Reference to Peristalsis and Antiperistalsis. *Bull. Johns Hopkins Hosp.*, 1920, **31**, 197-202.

A CORRELATION OF THE HISTOLOGIC CHANGES AND CLINICAL SYMPTOMS IN IRRADIATED HODGKIN'S DISEASE AND LYMPHOBLASTOMA LYMPH NODES¹

By ALEXANDER BRUNSCHWIG, M.D., Department of Surgery and Division of Roentgenology, University of Chicago, and ERNESTINE KANDEL, M.D., Department of Medicine, University of Chicago

INTRODUCTION

THERE has been such extensive, and at times confusing, discussion of the etiology and genetic relationship of Hodgkin's disease, lymphosarcoma and the leukemias, that it is necessary for anyone presenting a paper on the subject to define his own views. There is no question but that a typical Hodgkin's disease lymph node presents a characteristic histologic picture. Typical lymphosarcomas also constitute a pathologic entity. In lymphatic leukemia, the involved lymph nodes are practically identical in structure with lymphosarcoma, but in the former, the blood picture characterizes the condition. The infectious nature of Hodgkin's disease, especially in regard to tuberculosis, has not yet been conclusively demonstrated. Lymphosarcoma and lymphatic leukemia are considered true neoplastic diseases. There are, however, instances in which a histologic differentiation of Hodgkin's disease from lymphosarcoma or leukemias is impossible, even by the most expert pathologists. Warthin (1) cited such cases as evidence that all of these conditions are but variations of the same fundamental neoplastic process. He also reported cases of Hodgkin's disease that finally developed into leukemia.

A close relationship between lymphosarcoma and lymphatic leukemia has also been repeatedly demonstrated by those cases which were first lymphosarcoma and later developed into lymphatic leukemia (Kato and Brunschwig, 2). In fact, it appears that lymphosarcoma is a preliminary stage of lymphatic leukemia.

The use of the term "Hodgkin's disease" or "lymphogranuloma" is justifiable in

typical cases. The term "lymphoblastoma" has been employed to designate Hodgkin's disease, lymphosarcoma, and the lymphatic leukemias, collectively, but the writers prefer to apply it only to the two latter conditions.

It is generally admitted that the treatment of choice for this group of lymphoid neoplasms is irradiation. Excision of the affected lymph nodes is justified only in unusual circumstances. But experience has shown that, with few exceptions, irradiation therapy is at best palliative. A fatal outcome within from 3 to 5 years or less is the rule. However, a few proven cases of many years' duration are on record.

It seems paradoxical that the immediate results of irradiation therapy should be so satisfactory, and yet so little be accomplished toward permanent eradication. There is, as yet, no explanation for this. Histopathologic studies of irradiated Hodgkin's nodes have been recorded by a number of authors (Mayer, 3, Symmers, 4, Favre and Croizat, 5), but without close correlation with the clinical course. A short time after irradiation, foci of necrosis appear in the affected nodes with rather extensive cellular destruction. A diffuse sclerosis develops that ultimately replaces a large part of the cellular tissue. It has also been pointed out that in patients, who did not receive irradiation, such a sclerosis of the diseased lymph nodes will often develop spontaneously, so that the post-irradiation nodes and old untreated nodes in Hodgkin's disease may present the same histologic structure. Very few observations on irradiated lymphoblastoma are recorded. Warthin (6) made extensive studies on two postmortem cases which had received generalized irradiation for some time. He found a generalized sclero-

¹ Read before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.



Fig. 1. Case I. (Hodgkin's disease.) Photomicrograph ($\times 25$) of section from initial biopsy, showing dense cellular overgrowth, with scattered foci of normal lymphocytes and large normal germinal centers.



Fig. 2. Case I. Photomicrograph ($\times 20$) of section from lymph node removed after reduction in size, as a result of therapeutic irradiation. The greater portion of the gland has been sclerosed but islands of neoplastic tissue persist beneath the capsule (A).

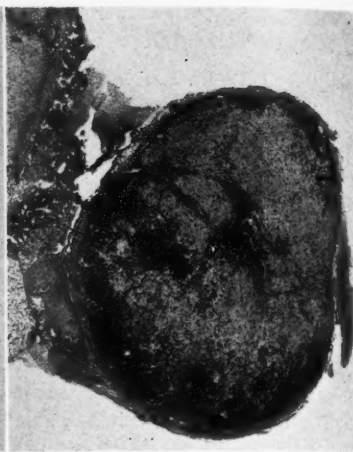


Fig. 3. Case I. Photomicrograph ($\times 25$) of right cervical node, showing histologic picture for recurrence. There is a proliferation of the subcapsular neoplastic remnants, with invasion of surrounding fibrous tissue, especially toward the center of the node. Compare with Figure 2, which shows the latent period shortly after irradiation.



Fig. 4. Case II. Photomicrograph ($\times 25$) of left cervical lymph node, some time after therapeutic irradiation. Enlargement did not recur in this group as it did in the opposite side because there has been complete sclerosis of the node and disappearance of practically all neoplastic tissue.

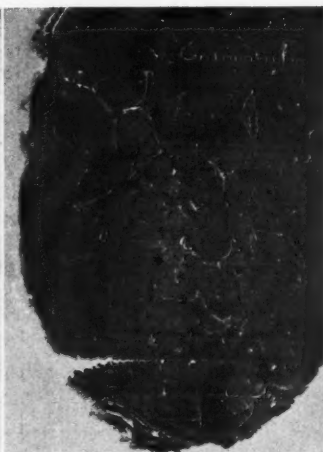


Fig. 5. Case IV. Photomicrograph ($\times 20$) of biopsy section from left cervical mass. There is a dense overgrowth of lymphoblasts that has destroyed the normal lymphoid architecture. No sclerosis. Diagnosis: Lymphoglastoma (lymphosarcoma).



Fig. 6. Case IV. Photomicrograph ($\times 20$) of section from left cervical mass removed at autopsy. Therapeutic irradiation was completed four weeks before, resulting in a clinical improvement. The patient became ill with acute lymphatic leukemia six days before death. There is a moderate diffuse sclerosis with accumulation of round cells (lymphoblasts) beneath the capsule. Compare with Figure 5, which shows the absence of sclerosis before irradiation.

sis in the bone marrow, spleen, and lymph nodes.

The following studies were made in order to correlate the clinical course of these conditions with the histologic changes in the irradiated tissue, and to determine, if possible, the reason for the failure of irradiation therapy to eradicate the disease.

The Affect of Irradiation on Normal Lymph Nodes.—As a control for the changes in Hodgkin's and lymphoblastoma nodes, to be described below, it is necessary to determine what effect irradiation has on normal lymphoid tissue. Ewing, Quick, and Cutler have demonstrated that, contrary to the earlier notions, normal lymph nodes are not sclerosed by extensive irradiation. They are, in fact, quite re-

sistant, and even undergo hyperplasia, the germinal follicles becoming prominent and containing numerous mitotic figures. The writers confirmed these observations in a lymph node removed from the cervical region along with a large neurofibroma of the brachial plexus, that had been irradiated some time prior to operation.

In the following cases, seen in the University of Chicago Clinics, the total doses employed in any series of treatments were from 500 to 800 r to one field (measured in air), delivered to the affected group of lymph nodes and sometimes to the adjacent groups which were not clinically involved (200 P.K., 25 ma., 50 cm. focal skin distance, 0.5 mm. Cu plus 1 mm. Al filter).

HODGKIN'S DISEASE

CLINICAL HISTORY

Case I. E. O., male, aged 16 years, was admitted to the hospital in September, 1930, because of swollen, upper right cervical lymph nodes of 4 months' duration, which formed a large mass about $6 \times 4 \times 4$ centimeters. There were no general symptoms. Physical examination was otherwise essentially negative. Spleen was not palpable. Blood was normal.

Deep x-ray therapy was given to the left and right cervical regions, followed by a complete regression of the mass.

In January, 1932, the patient's general health was unimpaired. Small shotty movable lymph nodes were felt in the right cervical region. A biopsy was performed.

In May, 1933, the patient is markedly emaciated, weak, and pale. He cannot gain weight in spite of forcing himself to eat. On physical examination, there are no enlarged superficial lymph nodes palpable. Nodes in the right cervical region are normal in size but firm and shotty. Spleen not palpable. There are no retroperitoneal masses. Roentgenogram of chest shows no

HISTOLOGIC FINDINGS

Biopsy of the cervical mass was done on admission. Section shows a dense cellular overgrowth composed of lymphocytes, plasma cells, some eosinophil and reticulum cells (Dorothy Reed), that have almost completely destroyed the normal lymph node architecture. There still remains a number of small scattered normal germinal centers, surrounded by narrow zones of normal lymphocytes. In places, there are large swollen endothelial cells. There is also a slight diffuse sclerosis.

Diagnosis: Hodgkin's disease (Fig. 1).

Biopsy sections of small right cervical lymph node showed almost complete replacement by dense fibrous and hyalinized tissue. Just beneath the capsule there are several small groups of large and small lymphocytes and plasma cells (Fig. 2).

In May, 1933, a biopsy of two right cervical lymph nodes was done. Sections of one node are practically identical with those just described, except for slightly more cellular tissue beneath the capsule. Sections of the other node also reveal marked central sclerosis, but there are rather large areas of large and small lymphocytes, plasma cells, and a number of re-

CLINICAL HISTORY—*Cont'd*

mediastinal masses. Blood: red blood count, 4,520,000; hemoglobin, 76 per cent; white blood count, 10,800.

Case II. J. C., male, aged 28 years, was admitted to the hospital in October, 1931, because of swollen bilateral cervical lymph nodes. The patient had been aware of these masses for the previous four years, yet experienced no general symptoms until two years ago, when he began to lose weight and felt constantly fatigued. On physical examination, the lymph nodes in both cervical regions were found to be enlarged to about 3 to 4 cm. in diameter, firm, movable, and for the most part, discrete; there was also slight enlargement of axillary and inguinal nodes. Liver was 1.5 cm. below costal margin; spleen was just palpable. Roentgenograms of chest showed a mediastinal mass with extension into the hilum of the right lung. White blood count, 8,000; hemoglobin, 58 per cent; red blood count, 3,980,000.

From October to November, 1931, the patient received deep x-ray therapy to both sides of neck, chest, and inguinal regions, followed by regression of the enlarged nodes to almost normal size. There was no improvement in the anemia, in spite of adequate iron therapy; there was little improvement in strength.

In March, 1932, although the patient had no complaints, he was pale and emaciated; lymph nodes almost normal in size. Spleen was barely palpable.

In June, 1932, the lymph nodes in right side of neck had rapidly increased to 3 to 4 cm. in diameter and had become quite tender. The nodes in left cervical region were not enlarged. General condition was poor. Evening rise in temperature to 101° F. White blood count, 8,000; red blood count, 3,090,000, differential normal; hemoglobin, 32 per cent. A biopsy was done of nodes in both cervical regions. Patient appeared too weak for further roentgentherapy.

In March, 1933, the patient died.

Case III. J. K., male, aged 30 years, was first seen on March 8, 1932, complaining of a large, firm, painless swelling 5 × 4 × 4 cm. below the angle of the left mandible, that had developed in the last two months. This was due to enlarged confluent upper cervical nodes.

HISTOLOGIC FINDINGS—*Cont'd*

ticulum cells beneath the capsule. This cellular tissue appears to be infiltrating into the central sclerotic area of the node (Fig. 4).

Biopsy, Oct. 5, 1931. The section shows three nodes adherent to one another by their dense fibrous capsules. No normal lymphoid architecture is present. It has been replaced by a dense cellular overgrowth of lymphoblasts, lymphocytes, plasma cells, and eosinophils. Large reticulum cells are numerous and aggregated into large foci. In places, there has been a marked proliferation of endothelial cells plugging up the few remaining visible sinuses. In addition to a diffuse sclerosis, there are many scattered round hyalinized masses. Diagnosis: old Hodgkin's disease.

Biopsy, June 24, 1932. Sections of the enlarged node removed from the right side show a dense sclerosis and numerous foci of necrosis about which were many polymorphonuclear cells. There are also many scattered areas of round cells and reticulum cells, each forming a small focus of "Hodgkin's disease tissue." The section of the lymph node removed from the left cervical region where enlargement of the nodes did not recur show it to be composed of dense fibrous tissue, with few nuclei. There are a few scattered foci of lymphocytes with no associated eosinophils or reticulum cells. These foci do not suggest remnants of the Hodgkin's tissue but appear to be a part of the sclerotic process that has involved the whole node. (See Fig. 4.)

On March 8, 1932, a biopsy of enlarged left cervical node showed a dense overgrowth of lymphocytes, some plasma cells, and lymphoblasts, eosinophils, and an occasional reticulum cell. There were small scattered areas of slight sclerosis. The architecture of the normal

CLINICAL HISTORY—*Cont'd*

The lower left cervical nodes were also enlarged, but discrete. There were no generalized symptoms; no anemia. Roentgenograms of chest showed no mediastinal masses.

One month later, he received x-ray therapy to both cervical regions. This was followed by complete regression of the masses.

Two months after roentgen therapy a second biopsy was performed on a small firm lymph node in the left cervical region. There were no generalized symptoms; no anemia. General condition was satisfactory.

July, 1933, another small firm lymph node was removed from the left cervical region.

From Aug. 12 to 19, 1932, he received x-ray therapy to both cervical regions.

In October, 1932, he returned to the clinic because of a mass 4 cm. in diameter in the left axilla. He had lost a little weight and felt weak. White blood count, 3,300; hemoglobin, 64 per cent, and red blood count, 3,900,000. No other superficial nodes were palpable. X-ray therapy was given to the left axilla.

On Dec. 28, 1932, the patient was readmitted to the hospital because of marked weakness and evening rise in temperature to 103° F., and loss of weight. White blood count, 1,600; hemoglobin, 66 per cent; red blood count, 5,080,000. Superficial lymph nodes were not enlarged; spleen not palpable, and roentgenograms of chest showed no mediastinal masses. Patient not seen since this admission.

Case IV. J. F., male, aged 18 years, was admitted on Nov. 14, 1928. He presented enlarged firm left cervical and left axillary lymph nodes of 13 months' duration. There were no general complaints. Blood picture was normal.

There was a regression of masses, following deep x-ray therapy and series of injections of Coley's toxins.

HISTOLOGIC FINDINGS—*Cont'd*

lymph nodes has been completely destroyed except for an occasional large focus of normal lymphocytes; obviously a remnant of the normal lymphoid tissue. Diagnosis: Hodgkin's disease.

June 10, 1933, biopsy sections revealed a cellular Hodgkin's node with scattered small patches of sclerosis. There were still some foci of normal lymphocytes as described above.

Biopsy, July 26, 1933. Sections showed a rather marked diffuse sclerosis in which the fibroblast nuclei were large. There were also many large reticulum cells, tending to form large foci. Scattered in the sclerotic background were a moderate number of round cells, lymphocytes, and lymphoblasts, and plasma cells and a large number of eosinophils.

Biopsy, Nov. 14, 1928, of left cervical node. Sections show destruction of normal lymph node architecture by dense cellular overgrowth of large and small lymphocytes, plasma cells, some eosinophils, and scattered reticulum cells. There was also a slight diffuse sclerosis.

CLINICAL HISTORY—*Cont'd*

In June, 1930, the patient was readmitted for recurrence of masses in left cervical and axillary regions. He stated that they began to develop six months after last admission and x-ray therapy. Other complaints were weakness, and loss of 14 pounds in weight. Roentgenograms of the chest showed upper mediastinal mass. Biopsy of left cervical lymph node was done. There was no anemia.

Deep x-ray therapy to left, axillary, cervical, and mediastinal regions, followed by regression of the lesions and improvement in general symptoms.

In October, 1931, the patient was readmitted because of recurrence of weakness, loss in weight, and reappearance of tumor masses, in last four months, in both axillae. They were not as large as before, now measuring about 2 cm. in diameter. Spleen was not palpable; roentgenograms of chest showed no recurrence of mediastinal mass; red blood count, 3,000,000; hemoglobin, 39 per cent; white blood count, 8,000. Temperature, 101–103° F. each evening.

The patient was too ill for x-ray therapy.

In January, 1932, he expired, 5 years after onset of symptoms.

In all the cases described above, the patients were benefited temporarily by irradiation, but no permanent cure was obtained. This improvement is represented histologically by a sclerosis of the nodes, a result of therapy. The sclerosis, however, is not complete because some of the neoplastic tissue survives in small quantities beneath the capsules of the nodes and is scattered throughout the central portions. The post-irradiation improvement continues for a varying period until there is a return of generalized symptoms and sometimes local and distant recurrence of enlarged nodes. The recurrence of local and general symptoms is represented histologically by a "lighting-up" of activity in the small patches of neoplastic tissue remaining within the sclerotic nodes. There is a proliferation of these cells with invasion of the surrounding fibrous tissue. Depending upon

HISTOLOGIC FINDINGS—*Cont'd*

Biopsy, June, 1930, of the left cervical lymph node shows a marked increase in diffuse sclerosis. Many large fibroblast nuclei were present. Large and small lymphocytes, lymphoblasts, plasma cells, and some eosinophils were scattered diffusely in the fibrotic node. There was an increase in number of reticulum cells as compared with the first sections.

Biopsy, October, 1931, of a lymph node in left cervical region. Sections show a dense sclerosis with hyalinization in certain areas and foci of necrosis. Many fibroblast nuclei are seen, but round cells are also present as a diffuse and focal infiltration. There are many scattered eosinophils, and associated with some of the larger accumulations of round cells are a number of reticulum cells.

the extent of recurrence, the lymph nodes again become quite cellular, or may remain sclerotic with large scattered cellular areas. However, there is never a return to the very cellular state that obtains before therapy. The sclerosis produced by irradiation will persist and is readily recognized, although it may become invaded again by round cells as a result of subsequent recurrences. If irradiation does not produce a rather extensive sclerosis, the immediate prognosis is poor, as illustrated by Case III.

In addition to sclerosis, two other features especially characterize an irradiated Hodgkin's node. First, the large number of eosinophils, and second, an increase (quite marked in some cases) of reticulum cells as compared with the number present before irradiation. At this time it is not possible to interpret these histologic findings.

LYMPHOSARCOMA AND LYMPHATIC LEUKEMIA

CLINICAL HISTORY

Case V. M. K., female child, aged 5 years, was admitted on Jan. 7, 1932, because of enlarged confluent left cervical lymph nodes which had formed a mass $8 \times 5 \times 5$ cm. and about which were other discrete enlarged nodes. There was no pain or tenderness. Physical examination otherwise negative. White blood count, 6,200; red blood count, 5,300,000; hemoglobin, 98 per cent, differential normal.

During the next three weeks, the patient received deep x-ray therapy to left and right cervical regions, left and right inguinal regions, left axilla and mediastinum. A few days after treatment began, there was marked regression of the left cervical mass, which almost completely disappeared a little later.

On Feb. 29, 1932, the patient was readmitted in a toxic condition with moderate enlargement of the left cervical nodes and slight enlargement of the right cervical nodes. A few days previously there had been an evening rise in temperature to 102° F., and hematuria. There were purpuric spots on the extremities and trunk, and bleeding from the gums. The liver and spleen were palpable. Red blood count, 2,740,000; white blood count, 179,000, consisting of 98 per cent immature lymphocytes. Diagnosis: acute lymphatic leukemia. The patient died in March, 1932.

Case VI. C. B., female, aged 49 years, was admitted on April 3, 1933, because of a slowly growing mass in the right side of the neck, present since December, 1932, and tender at intervals. This mass was $8 \times 5 \times 5$ cm., and obviously due to enlarged, confluent, firm, upper cervical lymph nodes. The lower right cervical nodes were discrete, rubbery, and moderately enlarged. White blood count, 6,200; hemoglobin, 80 per cent; red blood count, 3,690,000. Biopsy of the mass was done.

From April 6 to 12, 1933, deep x-ray therapy to both sides of the neck and right axilla.

In May, 1933, her general condition was excellent, but the mass had not regressed more than one-third in size. Because of this, it was removed surgically. A few weeks later, a second course of deep x-ray therapy was given. White blood count, 6,300; hemoglobin, 65 per cent;

HISTOLOGIC FINDINGS

Biopsy, Jan. 7, 1932, of the left cervical mass. Sections reveal normal lymphoid architecture completely replaced by a dense overgrowth of lymphoblasts, exhibiting numerous mitotic figures. There is beginning invasion through the capsule and into the surrounding areolar tissue (Fig. 5). Diagnosis: lymphoblastoma (lymphosarcoma).

Section from a lymph node in the left cervical region taken at postmortem examination on March 2, 1932, showed a rather marked diffuse sclerosis. Large round cells (lymphoblasts) were present in moderate numbers. In the central area of the node they were uniformly scattered in the fibrous tissue. Beneath the capsule they were more numerous, and aggregated into large dense foci. An occasional plasma cell eosinophil was present. There were also small scattered areas of cellular necrosis.

Biopsy sections revealed no normal lymphoid structure. Instead, this had been replaced by a dense overgrowth of large lymphoblasts exhibiting a moderate number of mitotic figures. Some fibrous bands were present but there was no diffuse sclerosis. Diagnosis: Lymphoblastoma (lymphosarcoma).

Biopsy one month after completion of deep x-ray therapy. Sections of the partially regressed mass show a marked diffuse sclerosis throughout and diffusely scattered, round and oval cells (lymphoblasts), presenting a few mitotic figures. There are a few polymorpho-

CLINICAL HISTORY—*Cont'd*

red blood count, 3,710,000. Smears showed no atypical leukocytes.

HISTOLOGIC FINDINGS—*Cont'd*

nuclear and plasma cells. There are no foci of necrosis; no dense hyalinized stroma.

Died at home in November, 1933, with recurrent masses in right cervical region and mediastinum.

Case VII. E. D., male, aged 58 years, janitor, was admitted in April, 1932, because of nodular swellings in the groins and axillae. The patient stated that he had been aware of these masses for the last 15 years, that they varied in size, and never were accompanied by constitutional disturbances. However, in the last two months, an increase in their size was accompanied by a progressive weakness, which prevented him from working. Physical examination revealed cervical, axillary, and inguinal nodes, measuring about from 3 to 5 cm. in diameter, discrete and movable. The spleen was palpable three fingers' breadth below the costal margin. Blood picture was normal; roentgenograms of chest showed no mediastinal mass.

Biopsy of left cervical node revealed a replacement of the normal lymphoid architecture by a dense overgrowth of cells, closely resembling mature lymphocytes—a few mitotic figures were present. There was no sclerosis. Diagnosis: lymphoblastoma (lymphocytoma).

From April 25 to May 9, 1932, deep x-ray therapy to all superficial groups of nodes that were clinically involved, and to the mediastinum.

By June, 1932, all nodes had regressed to normal size except in the inguinal regions, where they remained slightly enlarged. Weakness had disappeared.

In August, 1932, improvement was maintained. The patient was at work.

Biopsy, August, 1932, of a small firm nodule in the left cervical region. Sections showed a small node in which the normal architecture was destroyed due to a dense overgrowth of cells closely resembling normal lymphocytes. There was no sclerosis; essentially the same picture as seen above.

In October, 1932, the patient was readmitted because of extensive edema of the scrotum and inferior extremities, and marked weakness. Physical examination also revealed a large abdominal mass due to involved retroperitoneal lymph nodes. White blood count 5,000. Differential was normal.

Deep x-ray therapy to the abdomen.

In December, 1932, edema and retroperitoneal masses had disappeared. Patient felt practically well.

CLINICAL HISTORY—*Cont'd*

In April, 1933, his general condition was excellent and he was doing hard physical work. All nodes were normal in size, but could be readily palpated because of their firmness.

Case VIII. H. B., male, aged 72 years, was admitted on Aug. 29, 1931, presenting painless swollen lymph nodes, about 4 cm. in diameter, in both cervical and axillary regions, of three months' duration. Physical examination was otherwise negative. Biopsy was done of a left cervical node. There were no general symptoms. White blood count, 17,900; differential, polymorphonuclears, 44 per cent, large lymphocytes 12, small lymphocytes 42 per cent, mononuclears, 2 per cent.

In September and October, 1931, he received deep x-ray therapy to right and left cervical and axillary regions. There was a regression of enlarged nodes to almost normal size.

In January, 1932, x-ray therapy was repeated.

In April, 1932, there was a recurrence of egg-sized nodes in cervical, axillary, and inguinal regions. There were no general complaints. The blood picture was as before except for immature appearance of lymphocytes. These masses regressed under a third course of deep x-ray therapy.

In September, 1932, there was a second recurrence of enlargement of cervical nodes. Biopsy was done of a node in the left cervical region.

In October, the blood count was as follows: white count, 32,000; polymorphonuclears, 12 per cent; lymphocytes, 87 per cent; red blood count, 4,140,000; hemoglobin, 98 per cent. Diagnosis: Chronic lymphatic leukemia.

Deep x-ray therapy to cervical regions repeated, with regression of masses.

In December, 1932, the patient was readmitted to the hospital suffering from lobar pneumonia—entire right lung. Superficial lymph nodes were small but firm. White blood count, 110,000, 91 per cent of which were small lymphocytes. The patient died.

HISTOLOGIC FINDINGS—*Cont'd*

Biopsy, April, 1933, of a left cervical node revealed essentially the same picture as described above, namely, a lymph node the normal structure of which was replaced by a dense cellular growth of cells closely resembling lymphocytes. *No sclerosis was present.*

Biopsy. Sections from the excised lymph node revealed a replacement of the normal lymph node structure by a dense overgrowth of large round cells (lymphoblasts), exhibiting a moderate number of mitotic figures. There was no sclerosis. Diagnosis: lymphoblastoma (Fig. 7).

Biopsy sections showed essentially the same picture as described above. There was no sclerosis.

A section of a lymph node, removed from the left cervical region at postmortem examination, showed essentially the same structure seen on the initial biopsy. *No sclerosis was present.* There were a few scattered hyalinized areas but these were similar in appearance to those often seen in the germinal centers of normal hyperplastic nodes, and were obviously not the result of irradiation. Diagnosis: chronic lymphatic leukemia (Fig. 8).

The four cases described above may be divided clinically into two groups: Cases V and VI may be considered quite malig-

DISCUSSION

From the above studies, it is apparent



Fig. 7. Case VIII. Photomicrograph ($\times 20$) of biopsy section from left cervical mass before therapeutic irradiation. Normal lymph node structure has been completely destroyed by dense overgrowth of mature lymphoblasts. Diagnosis: Lymphoblastoma (chronic lymphatic leukemia).



Fig. 8. Case VIII. Photomicrograph ($\times 20$) of section from left cervical node, removed at post-mortem. Although nodes in this region were irradiated on several occasions and twice reduced to normal size, there is no sclerosis, the node being as cellular as at the initial biopsy (Fig. 7).

nant because, in one, shortly after irradiation, a rapidly fatal acute leukemia developed, and in the other, there was not a satisfactory regression of the tumor mass. Cases VII and VIII may be regarded as less malignant because, in one, the disease has been present for many years, and in the other, it pursued a chronic course for two years after irradiation therapy was first instituted, the patient dying of an intercurrent infection. There is also a marked difference in the histologic reactions of these two groups to irradiation. In the more acute or malignant cases, there was a diffuse sclerosis of the irradiated nodes. In no instance, however, did this sclerosis compare with that seen in the Hodgkin's nodes. In the more chronic or less malignant cases the nodes were reduced in size but there was no sclerosis.

that irradiation therapy did not in any instance cause a complete disappearance of the neoplastic tissue. In Hodgkin's disease, improvement was brought about by materially reducing the quantity of the neoplastic tissue, but recurrences developed from the small amounts that remained.

Since each node received practically the same irradiation throughout, the persistence of small amounts of neoplastic tissue beneath the capsule and as small foci in the central portions of the node indicates a difference in radiosensitivity within this tissue. This would explain the apparent increase in radioresistance of each recurrent enlargement, since in such recurrences the neoplastic tissue is derived by proliferation of the more radioresistant cells. Thus the apparent existence of radioresistant and radiosensitive cell strains in Hodgkin's disease would indicate

that the theory of Regaud, for the growth and development of squamous-cell carcinomas, is perhaps also true for Hodgkin's sarcoma. For, according to this theory, the growth of a neoplasm is similar to the proliferation of a seminal epithelium. There are "mother cells" that divide, giving rise to similar "mother cells" and "daughter cells," the former corresponding to the spermatogonia, and the latter, maturing more than the former, correspond to primary and secondary spermatocytes and spermatozoa. The "daughter cells" are radiosensitive and are easily destroyed. The "mother cells" are radio-resistant and destroyed only with difficulty. Hence, when recurrences develop after irradiation, it is from the "mother cells" that have persisted.

Thus, in Hodgkin's disease, if it is true that from the beginning the process involves the entire reticulo-endothelial system, irradiation therapy has little more than palliation to offer. On the other hand, if it begins as a local process and the primarily involved group of lymph nodes is discovered on physical examination early in the course of the disease, heavy irradiation of this and adjacent groups, with the object of completely sclerosing the affected nodes, offers a possibility of improving the therapy of this condition.

The problem in lymphoblastoma is more complicated. It is possible, in the more chronic cases, to reduce the enlarged nodes to normal size, yet, biopsy reveals that these small post-irradiation nodes are not sclerotic but are as cellular as the initial growth, containing large numbers of viable tumor cells. In the two cases of lymphoblastoma reported above, in which moderate diffuse sclerosis did occur, the clinical course indicated that the progress of the disease was not very favorably influenced by such changes.

SUMMARY AND CONCLUSION

(1) Irradiation of Hodgkin's lymph nodes, according to the usual technic, results in a widespread replacement of the cellular tissue by dense sclerosis.

However, small scattered masses of neoplastic tissue usually survive beneath the capsule or within the central portion of the sclerotic node. This indicates a variation in radiosensitivity of the Hodgkin's disease tissue.

After a latent period this cellular tissue begins to proliferate and infiltrate the surrounding sclerotic areas. This constitutes a recurrence. Increased numbers of reticulum cells and eosinophils usually characterize the histologic appearance of such recurrences. The clinical improvement coincides with the sclerosis of the nodes, and the recurrence of general symptoms corresponds to the proliferation of the neoplastic tissue after the initial sclerosis of the node.

(2) As shown in one case reported above (Case II), almost complete sclerosis of Hodgkin's nodes can be brought about by irradiation. When this obtains, the possibility of local recurrence is greatly minimized.

(3) If, as has been maintained, Hodgkin's disease affects the entire reticulo-endothelial system from the start, little more than palliation can be expected from irradiation therapy. On the other hand, if the process is at first a local one, and if the involved group of lymph nodes is discovered on physical examination early in the progress of the disease, intense local irradiation, with the object of completely sclerosing the lymph nodes, may offer a possibility of arresting the process.

(4) Irradiation of lymphoblastoma nodes may result in a reduction in size and some sclerosis, if the process is of the more malignant type. In the chronic cases, the nodes are reduced in size but not sclerosed.

(5) From the histologic standpoint lymphoblastoma is more radioresistant than Hodgkin's disease.

BIBLIOGRAPHY

- (1) WARTHIN, A. S.: The Genetic Relationships of Hodgkin's Disease, Aleukemic, and Leukemic Lymphoblastoma, etc. Cancer (Ewing Memorial Edition), J. B. Lippincott Co., Philadelphia, 1931, p. 153.

(2) KATO, H., and BRUNSWIG, A.: Archives of Internal Med., January, 1933, 51, 77-89.

(3) MAYER, K.: Histologisch Veränderungen des Lymphogranuloms unter der Wirkung der Röntgenstrahlen. Frankf. Zeit für pathol. Anat., 1919-1920, 22, 943.

(4) SYMMERS, D.: The Clinical Significance of the Pathological Changes in Hodgkin's Disease. Am. Jour. Med. Sci., 1924, 167, 313.

(5) FAVRE, M., and CROIZAT, P.: Caractere generaux du granulome malin tires de etude anatomoclinique. Annales d'Anatomie Pathologique, 1931-1932, 8, 838.

(6) WARTHIN, A. S.: Über die im leukamischen Gewebe durch Röntgenbestrahlung hervorgerufenen Veränderungen. Strahlentherapie, 1914, 14, 722.

(7) EWING, JAMES: Tissue Reactions to Radiation. Am. Jour. Roentgenol. and Rad. Ther., 1926, 15, 93.

950 E. 59th St.

ROENTGEN-RAY VISUALIZATION OF PART OF THE LYMPHATIC SYSTEM

By LEON J. MENVILLE, M.D., F.A.C.R., and J. N. ANÉ, M.D., *New Orleans*

Radiological Division, Department of Medicine, Tulane University of Louisiana

BECAUSE the origin and anatomic arrangements of the lymphatics were not clearly understood for a long time conflicting views were advanced in an attempt to explain the method of lymphatic absorption of particulate matter and micro-organisms. Some authorities believe that the lymphatics originate in the tissue spaces directly drained by lymph capillaries; others believe that the lymphatics are a closed system of vessels, comparable with the blood vessels.

It can be appreciated that the mode of entrance of solid particles, such as pigments or micro-organisms, into the lymphatic system will depend in a large measure upon the anatomic arrangement of the latter. If the lymphatic vessels originate as tissue spaces, minute solid objects would enter directly into the lymphatics without difficulty; but if the lymphatics are a closed system, entrance into them could be accomplished only by living cells, acting as phagocytes, passing into the lymph by diapedesis. Many experiments have been conducted by numerous observers in an attempt to clarify the mode of absorption of the lymphatic system. Outstanding is the work of Herring and MacNaughton (1). By injecting insoluble substances such as carbon and carmine, into the subcutaneous tissues of the legs of animals and recovering them in the lymph nodes, these two workers have been able to prove that the lymphatic system absorbs the substances. They also found that the tissue spaces are not directly continuous with the lymph capillaries and that the injection of insoluble substances, such as India ink and carmine, into the loose connective tissues may spread them widely through the tissue spaces. Herring and MacNaughton conclude that many of these solid particles are taken up in the cyto-

plasm of cells which passes through the walls of the lymphatics by diapedesis into the lymphatic system.

Their contention is: "The phagocytic cells are arrested in the first lymph gland on the lymph stream, and the cells carrying solid particles pass from the lymph sinuses of the gland into the lymph tissue of the cortex and medulla of the gland, and eventually discharge their burden among the lymphocytes in these situations. Solid particles, and even red corpuscles, arriving at the gland in a free state in the lymph stream, are dealt with by the endothelial cells of the reticulum of the lymph tissues. These cells, analogous to the Kupffer's cells of the liver sinusoids, ingest material, detach themselves, and carry into the lymphoid tissue of the gland in exactly the same way."

This is the explanation of the mode of absorption by the lymphatics when thorium dioxide, subcutaneously injected, is used to visualize the lymphatic system. Thorium dioxide, being a colloidal preparation containing particles of thorium, its absorption by the lymphatic system should be like that of India ink and carmine, as found by Herring and MacNaughton in their experiments.

In a preliminary report (2) and paper (2a), we reported that it was possible to visualize lymph nodes and vessels by subcutaneous injection of thorium dioxide without resorting to the surgical means previously used by others. Carvalho and his co-workers (3) have reported that they were able to visualize lymphatic vessels by surgically injecting certain opaque substances directly into the lymph nodes. They stated that in work planned for the future they would outline their technic and indicate the opaque substances used in their experiments, as well as their re-

sults. While their experiments are interesting, they have but little practical application; with them, it becomes necessary to dissect the nodes surgically in preparation for injection. Again, it can be appreciated that, unless the body was subjected to a general dissection, it would be practically impossible to find many such nodes to be injected.

Since the publication of our preliminary report on the visualization of portions of the lymphatic system, we have been able to visualize other portions beside those reported in our previous work, employing in these experiments the intraperitoneal and intradermal methods of injection. Some of these later observations have been published in certain medical journals; others, we present now for the first time. In a recent issue of the *Proceedings of the Society of Experimental Biology and Medicine* appears a preliminary report on the roentgen-ray study of absorption of thorium dioxide from the peritoneal cavity of the albino rat (4). We were able to demonstrate that, when thorium dioxide is injected into the peritoneal cavity of a rat, it is quickly absorbed by the lymphatic system of the diaphragms, and then is apparently carried by the lymphatics of the thorax into the right and left lymphatic ducts.

By means of roentgen-ray films we were able to show very fine striations in the abdomen which closely resembled lymph vessels, as we reported earlier. The diaphragms showed an accumulation of thorium, suggesting absorption, in their lymphatics. The thorax clearly showed the intercostal glands and vessels, and the connection of these vessels with what may be the right and left lymphatic ducts. Thus we demonstrated the drainage system of the lymphatics from the peritoneal cavity, diaphragm, intercostal nodes and vessels, and into the lymphatic ducts. We believe that this is the first time this portion of the lymphatic system has been visualized with the roentgen ray. The intraperitoneal injection of thorium dioxide did not injure the rats—they remained in perfect health for months.

Recently we injected thorium dioxide into the peritoneal cavity of dogs and rabbits, observing the route of absorption by the lymphatic system. It was similar to that seen in the rat, but a different portion of the lymphatic system of the thorax was visualized because the lymphatic system of the dog and rabbit differs from that of the rat. In the dog there is an absence of intercostal lymph vessels and glands, prominent in the rat. We were able to clearly visualize the right and left sub-sternal glands, situated on the course of the internal thoracic vessels; also the anterior mediastinal gland. In the posterior mediastinum we found a clump of glands, probably the tracheo-bronchial lymph nodes. Surrounding and also near the trachea were found lymph structures, probably the lymph glands which occur on the ventral face of the trachea and esophagus, and also the glands usually present between the trachea and the thoracic inlet and those on the right side of the trachea. The anterior and posterior mediastinal lymph vessels were clearly visualized, beginning in the region of the diaphragm and finally ending in the region of the lymphatic ductus. We believe that this is the first time it has been possible to study the lymphatic system of the thorax of the dog.

The experiments reported here not only demonstrate that thorium dioxide, when injected into the peritoneal cavity, can be used as a diagnostic aid through the visualization of certain lymphatic structures of the diaphragm and thorax, but that it is helpful for a clearer understanding of the high phagocytic capability of the lymphatic endothelial cells in removing large amounts of particulate matter from the peritoneal cavity, by the roentgen visualization of certain of these structures. We are inclined to believe with Cunningham (5) that the transfer of granular material from the peritoneal cavity into the diaphragmatic lymphatics takes place by means of a type of phagocytosis. The practical application of this knowledge is found in the well-known Fowler position in which, upon elevation of the head of

the bed after operations for abdominal infections, the infected material is permitted to gravitate toward the pelvic peritoneum. Here absorption takes place with comparative slowness, while the peritoneum in the upper abdomen absorbs very rapidly.

We consider our reported experiments on the visualization of different portions of the lymphatic system to be of value both from a diagnostic and a therapeutic standpoint. The possible visualization of lymph nodes in man could be of invaluable assistance to the surgeon in locating metastatic nodules before and after operation and in observing the effect of irradiation on certain glandular diseases. Lymphatic visualization would also be of considerable help to internists in the diagnosis and treatment of certain diseases which have a direct relation to the lymphatic system.

While we have reported that it is possible to visualize normal lymph nodes and vessels of different portions of the lymphatic system in the living, it should be appreciated that it may be shown in the future that diseased lymph nodes may or may not lend themselves to being visualized by the injection of thorium dioxide. It is probable that certain pathologic changes occurring within the internal structures of lymph nodes as a result of disease, prevent the absorption of thorium in sufficient quantity to cast a shadow. We have particularly in mind lymphatic metastasis. If it should be shown that metastatic lymph nodes are not susceptible to visualization, this fact alone could be of great diagnostic importance. We are at present making certain investigations in this regard, and hope soon to be able to publish our results.

We believe that if it can be shown that metastatic nodules absorb thorium, it may prove a most important factor in the treatment of cancer, in spite of the report of Irwin (7), who states that he did not find signs of any pathologic process in lymphatic nodules which had absorbed thorium. We base our belief partly on the report of the histopathologic examina-

tions of some of the lymph nodes of normal dogs which had absorbed a certain amount of thorium (6). Harris says: "In the case of the animals employed in these experiments, which were injected subcutaneously, the lymphatic glands being thereby visualized, there occurs a distinctly stimulating reaction upon the connective tissues, or stromal unit of the glands, with loss of the lymphoid structure. At times, associated with the connective tissue increment, there occurs an enlargement and evident stimulation of the cortical nodules, indicated especially by the great increase of the germinal, or *keim*, centers. The feature of unusual interest is the perivascular connective tissue proliferation which continues to increase concentrically about the blood vessels. Phagocytic cells which contain thorium can be seen within the lymph sinuses. A more advanced picture of such changes presents complete loss of the parenchyma, with connective tissue replacement in which the lymph spaces are clearly shown and, at times, dilated. Occasionally masses of phagocytic cells containing thorium show a surrounding encapsulation of connective tissue. At the site of local inoculation, masses of foreign body giant cells, or macrophages, are found, heavily laden with thorium granules.

"The biologic effects produced upon the lymphatic glands visualized by the subcutaneous injection of thorium are unusual in character and differ from those resulting from radium and the x-ray."

Dr. Harris' report indicates that great changes had taken place in the nodes, changes different from those usually seen after irradiation. The inference may be drawn from Dr. Harris' observations that thorium in colloidal form can be the means of normal cell destruction. While no definite proof has yet been shown that the radioactivity of thorium is sufficient to produce such changes, nevertheless we cannot at present disprove such a possibility. Then, again, thorium may exert some unknown destructive effect on normal lymph cells, such as the pathologist reports. In fact, his examination could be interpreted

to mean that the changes brought about in the lymph nodes were so extensive as to render the latter unfit to carry on the usual function of such glands. For this reason, were it possible to produce these changes in metastatic nodules, it would be the equivalent of surgical removal.

Then, again, because it has been shown by Schlundt (8) that thorium dioxide contains both thorium B and thorium D, and that the quantity of these substances in thorium dioxide depends somewhat upon the age of the thorium used in preparing thorium dioxide, the presence of thorium B and thorium D may play an important part in the treatment of cancer. It is well known that they emit characteristic rays which may have biologic effect when suitable roentgen rays are applied to them. It is also possible that the radio-activity of thorium may be shown to have some biologic effect, although Schlundt, in a personal communication, states that his investigation of thorium dioxide is not sufficiently advanced for him to express an opinion as to whether or not the radio-activity of thorium has an appreciable effect from the biologic standpoint.

SUMMARY

In our experiments we were able to visualize lymph nodes and vessels of different animals by subcutaneous, intradermal, and intraperitoneal injections of thorium dioxide. The following lymph nodes and vessels were visualized: popliteal, in-

guinal, mesenteric, axillary, substernal anterior mediastinal, posterior mediastinal, and intercostal lymph nodes; also lymphatic vessels of the abdominal cavity, the diaphragm, and the thorax.

None of the animals suffered ill effects from the injection of thorium dioxide. The subcutaneous injections did not produce abscess or sloughing, nor even redness or swelling of the skin. We were unable to observe any abnormal behavior of the rats which received intraperitoneal injections. Their appetite and general behavior were normal in every way.

REFERENCES

- (1) HERRING, P. T., and MACNAUGHTON, F. G.: Lymphatics and Lymph Glands. *Lancet*, June 3, 1922, **1**, 1081-1085.
- (2) MENVILLE, LEON J.: Verbal report, Southern Branch, Soc. Exp. Biol., April 8, 1932.
- (2a) MENVILLE, L. J., and ANÉ, J. N.: Roentgen Visualization of Lymph Nodes in Animals. *Jour. Am. Med. Assn.*, May 21, 1932, **98**, 1796-1798.
- (3) CARVALHO, R., RODRIGUES, A., and PEREIRA, S.: La Mise en Évidence par la Radiographie du Système Lymphatique chez le Vivant. *Ann. d'anat. path.*, February, 1931, **8**, 193-197.
- (4) MENVILLE, L. J., and ANÉ, J. N.: Roentgen-ray Study in Absorption of Thorium Dioxide from the Peritoneal Cavity of the Albino Rat. *Proc. Soc. Exper. Biol. and Med.*, October, 1932, **30**, No. 1, pp. 28-30.
- (5) CUNNINGHAM, R. S.: Studies in Absorption from Serous Cavities; on Passage of Blood Cells and Granules of Different Sizes through Walls of Lymphatics in Diaphragm. *Am. Jour. Physiol.*, October, 1922, **62**, 248-252.
- (6) HARRIS, WILLIAM: Histopathologic Effects of Thorium Dioxide on Lymphatic Glands of Animals Visualized by the Menville-Ané Method. *Proc. Soc. Exper. Biol. and Med.*, June, 1932, **29**, 1049, 1050.
- (7) IRWIN, DUDLEY A.: The Experimental Intravenous Administration of Colloidal Thorium Dioxide. *Canadian Med. Assn. Jour.*, August, 1932, **27**, 130.
- (8) SCHLUNDT, HERMAN: Personal communication, Nov. 4, 1932.

STIMULATING ACTION OF RADIO-ACTIVE DEPOSITS IN THE BODY¹

By FREDERICK B. FLINN, PH.D., *New York City*

From the College of Physicians and Surgeons, Columbia University

EXPERIMENTS in our laboratory, soon to be reported in the "American Journal of Cancer," indicate that there is no direct stimulation of tissue grown *in vitro* by radium which causes an uncontrolled increase in the rate of mitotic division. Our clinical observations point to some alternative explanation, namely, an over-response by the tissue to a destructive or irritating action. This is consistent with the history of malignancy which developed from an over-exposure among the early radiologists, and is further suggested by the bone necrosis which has been found to occur when radium seeds, improperly screened, have been placed in the oral cavity. This necrosis does not appear as a rule until several years after the exposure. In neither instance is there any radio-active deposit in the body. The action is local and indicates that some element in the cell has been injured, the effect of which does not become apparent for some time. This latent action due to radiation is still unexplained.

The evidence so far produced suggests that the action of radium does not follow the Arndt-Schultz law, namely, that large doses destroy and weak doses irritate. My observations, while growing tissue *in vitro* surrounded by a radio-active medium, leads me to believe that the action of radium is always destructive; that it is a matter of the chance impact of the alpha particle or gamma ray on some vital portion of the cell—probably the nucleus—which causes either the immediate or a delayed death of the cell. The smaller the amount of radio-active deposit present, the less chance there is for this impact to take place within any certain time. This opinion is further strengthened by clinical observations. The same type of destruc-

tion takes place in our cases whether the deposit is large or small, and, furthermore, it becomes just as extensive with the passage of time. The irritation, which may be an etiologic factor in causing malignancy, is the result of the condition of the tissue brought about by the exposure rather than because of the direct irritating action of radium itself.

The first case of radium poisoning that came under my direct supervision was in 1926. It was primarily a case of antral sinusitis and a necrotic involvement of the mandible, ending in general septicemia. In 1924, the patient, while dancing in her home, had suffered a spontaneous fracture of the femur which did not knit. At the time of our examination, the two ends of the fracture overlapped, and were banded together by means of a silver ring. Because of our lack of knowledge, in 1926, as to the action of radium when deposited in the body, we did not believe that there was any connection between the fracture and her industrial exposure. The radiograph of the bone showed no pathologic lesions. At autopsy, no indications of malignancy were found at the area of fracture. It is interesting to note that radiographs of other cases of fractures taken several weeks before failed to reveal any condition that would warn one of such a possibility.

Two years later, another case of jaw necrosis came under my observation and, as an aid to the study, a complete series of radiographs were taken of the entire skeleton by Dr. Joseph Steiner. Radiographs of the skull showed a number of areas of rarefaction—"moth-eaten" in appearance—which made one suspicious of myeloma. The other bones with the exception of the mandible were normal in appearance. The "moth-eaten" areas in

¹ Received for publication, June 29, 1934.



Fig. 1. Right femur.



Fig. 2. Left femur.

the skull were found to occur frequently enough as to assume diagnostic value when it was found that the patient had been engaged in dial painting. The areas increase in number and size as the case progresses. It became a routine practice to radiograph the complete skeleton of every case that came under our supervision.

We have had three other cases of spontaneous fractures for study. One occurred in a patient while walking across the floor, and another while the patient stepped down from a chair. The third and most recent one is an impacted fracture of the neck of the left femur which happened when the patient made a misstep while descending the stairs. In none of these cases did a fall precede the fracture.

There was no sign of healing in the first case for over four months. Administration of viosterol was then begun and at the end of six months a solid union took place. Radiographs taken a year later revealed that there had been a spontaneous fracture of one of the ribs, which had healed in the meantime. At the present time, the patient is suffering from ankylosis of the pelvic girdle with areas of rarefaction appearing in the vertebræ and around the pelvic bones. In spite of this deformity, she gave birth to a healthy child this past winter, a Caesarean operation being necessary. When I saw her a few weeks ago, ankylosis was developing around the shoulder girdle and she was unable to raise her arms to her neck. A cataract of

both eyes is gradually developing which leaves her completely blind when out of doors, although within the house with the

firm callus. The second fracture, which was proximal and also transverse to the first, had been operated on and plated, the

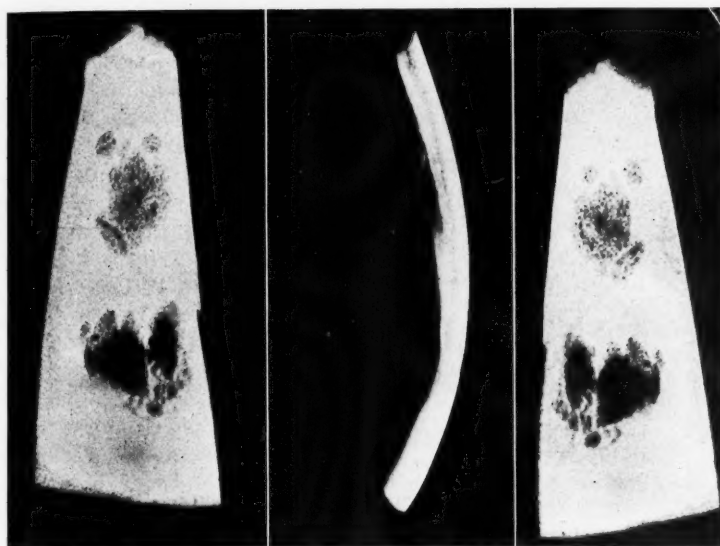


Fig. 3 (left). Exterior side of skull; (right), interior.

expanded iris she can still distinguish the number of fingers held in front of her face. We have observed this same eye condition in some of our experimental animals.

The second case is interesting in that the first fracture occurred in May, 1928, 11 years after the woman had left the industry. This healed with callus formation but very little calcium deposit. In November, 1929, while moving around the house, she suffered a second fraction above the first in the same femur. There has been no evidence of any union taking place at the site of the second fracture. In December, 1931, she underwent an operation in an attempt to correct this condition. This gave us an opportunity to obtain a biopsy specimen of the bone at the site of fracture for histologic study. The gross pathology then noted showed that there had been two different fractures of the femur at different times. The lower of these was rather oblique and had healed with slight moderate angulation but with

plate afterwards being removed. There had developed at the site of this proximal fragment a pseudo-arthritis with a well defined thick fibrous capsule. The bone was distinctly softer than normal, with a cortex about half the normal thickness. This was thought to be due in part to disuse, but more particularly to the severe radium poisoning which began about 12 years previous to the observation. Up to the Spring of 1934 no callus had formed at the site of the fracture, and recent radiographs show that cracks are beginning to appear in the left femur (Figs. 1 and 2). This is the Case No. 7 described by Martland (1), in 1931, as presenting a "strong presumptive evidence that sarcoma is developing." Radiographs and a gross examination of the bone in December, 1933, showed no signs of malignancy.

We ourselves have had two cases of sarcoma. The radiograph readings on these cases before sarcoma appeared are interesting from the viewpoint of our study.

Case A. There is a symmetrical decalcification and increased calcification of the pelvic bones. The increased calcium is



Fig. 4. Photomicrograph of bone destruction in the "moth-eaten" areas of the skull.

about the acetabulum and extends upward along the inner half of each iliac bone to the sacro-iliac joints. The eighth dorsal vertebral body is almost completely destroyed, there being an increased calcium content above and below it. Unfortunately, no autopsy could be obtained on this case.

Case B. Films of both extremities show a peculiar dense stippling within the cancerous structure of the os calcis and tarsal bone. The right femur shows some thickening of the cortex in the lower and inner aspects which is of questionable significance and probably can be discarded. Films of the shoulder girdles show the same peculiar stippling within the head of the humerus as was noted in the tarsal region. Films of the spine and skull are apparently negative. However, a film of the pelvis shows more of the osteoblastic reaction as previously described in Case A. There seems to be a mixed osteoblastic and osteolytic process along the sacro-iliac regions, the margins of the pelvic brim, both acetabular regions, and also within the left greater trochanter. The pubic bones also

appear involved. The iliac wings appear to have some diffuse loss of lime salts. The most marked findings are around the left hip joint.

Dr. P. C. Swenson is quoted as follows: "This is apparently the second case we have seen which has shown an osteoblastic reaction to radium unless it can be that we are dealing with a possible osteitis deformans. However, this seems a remote possibility." It was from these observations that the study of the stimulating action of radium was suggested.

The doctor in charge of the case was warned in March, 1931, to be on the lookout for sarcoma. He was skeptical at first, but in September of that year, the tumor first became evident and grew rapidly, the patient dying in December, 1931. Autopsy showed that the entire left side of the pelvic cavity was filled with a soft mass which had its origin at the region of the acetabulum. This mass had displaced all the pelvic organs, the bladder and uterus lying against the right pelvic brim. In removing the mass, it was found that the left innominate bone was partially destroyed and very friable, with many jagged points. No evidence of metastases were present. Histologic examination showed the tumor to be myxosarcoma.

Four cases of brain tumor have occurred among our patients, and in all of them the "moth-eaten" areas in the skull have been found. In our animal observations practically all of the tumors occur at the site of the fracture. On examination, in cases in which they do not occur at the site of the fracture, the shaft of the bone is found to be pitted and grooved and resembles in gross appearance the lesions found in the skulls. In these instances, the beginnings of tumors are seen in the marrow.

In none of these cases, or in our animal experiments, have we seen any indication of a stimulation of the bone marrow as indicated by an increased number of red cells in a peripheral sample. These are also the findings of Dr. Sabin and her co-workers (2) in rabbit experiments. The

only cases showing a polycythemia of which we have any record were those of four English girls examined for me, in 1925, by Dr. A. B. Rosher, Charing Cross Hospital Medical School. They showed a red blood count, respectively, of 5.60, 4.92, 5.60, 4.98. There might be some question as to whether these figures really indicated a true polycythemia. These girls had worked at dial painting, pointing the brush in their mouths, from one to eight years previous to the examination. However, they showed no ill effects from the occupation, and from the last information we received were still in good health.

HISTOLOGICAL

At autopsy, we were fortunate in obtaining specimens of skull from two cases in which the "moth-eaten" areas were present. Figure 3 shows a radiograph taken of the specimen which had been removed from one of the brain tumor cases.

Case 1. Microscopically, the rarefied areas consist of a loose fibrous connective tissue with only a few small islands of bone. Along the margins of the lesions there is considerable irregularity of the bone, some portions of the margin being rather irregular and others very smooth. The connective tissue is rather acellular. About the blood vessels are seen occasional myeloid foci and lymphocytes, along with scattered hemorrhages.

In this case, the internal surface of the right femur showed a productive exostosis extending about 4 centimeters.

Case 2 (gross). There is a sharply circumscribed lesion about 12×30 mm. in diameter within the substance of the bone. It extends through the calvarium except for a narrow strip on the external side about 0.5 mm. thick. The internal surface of the skull is slightly depressed at the site of the lesion. This area is very irregular, consisting almost entirely of necrotic bone fragments, and is softer than the surrounding bone.

Microscopically, the section shows fibrous and sometime aveolar connective tissue with occasional islands of bone.

Most of the bone is well preserved, but there are many small amorphous islands of bone. The margins of some of the

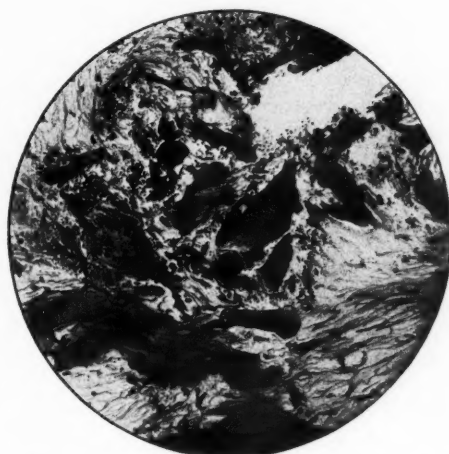


Fig. 5. Photomicrograph of bone destruction in the "moth-eaten" areas of the skull.

bony trabeculae show much fragmentation, which varies in intensity in different parts of the section. About the necrotic areas, the dense fibrous connective tissue is acellular. Several small hemorrhages and myeloid foci are scattered through the avascular connective tissue. No inflammatory reaction is seen. Figures 4, 5, and 6 show various stages of bone destruction in the "moth-eaten" areas in the skull.

The impression given by these specimens is that some agency locally situated is capable of slowly wearing away the bone tissue that surrounds it, with gradual enlargement of a roughly circular area of bone destruction, followed by replacement with fibrous tissue.

Fracture Case 2. Biopsy specimen removed at operation in a fracture case. The gross specimen is a mass of bone taken from the upper third of the shaft of the femur at the site of the fracture. It is covered on one surface with fibrous tissue; opposite this, is some of the yellow marrow. Starting across from one surface almost to the other is a slit-like separation. The bone

seems hard and dense and shows no evidence of decalcification.

Microscopically, the fracture line con-



Fig. 6. Photomicrograph of bone destruction in the "moth-eaten" areas of the skull.

sists of dense fibrous connective tissue that joins the bone without any evidence of new bone formation. In places, there is bone necrosis with fragmentation and loss of bone corpuscles. Some of this necrotic bone is being reorganized by new bone formed from osteoblasts. Small areas of osteoclasia are scattered among the fragmented spicules. The marrow shows almost no myeloid elements; in fact, for the most part, it is replaced by connective tissue in which are many new fibroblasts. Some of the blood vessels in the marrow have greatly thickened intima. The bony fragments consist of spicules that hardly show any evidence of new bone formation.

There may be a question in the minds of conservative pathologists as to how many of these findings should be assigned to fracture and how many to the action of radium. But inasmuch as the same lesions can be produced in animals which have been injected with radium, one feels inclined to think that the major portion of the effects are due to the action of the radium deposited in the bone.

DISCUSSION

We have presented our data in detail because we feel that possibly further experiments with radium may lead to some explanation of the occurrence of sarcoma in Paget's disease. Bird (3) has reported five cases in which, he states, a sarcoma has arisen in bone involved in osteitis deformans. We have had the two cases reported here in which there was perhaps a suggestion of osteitis deformans. Our work does not lead to a conclusion that the tumors in the radium cases are caused by direct stimulation, but rather to some specific bone condition which may produce an irritation resulting in an over-response of the organism.

To understand or to get a picture of the action of the radio-active deposits in the body, one must bear in mind certain facts. When the tissue is exposed to radium externally, it is subjected, if the radium is properly screened, only to the gamma ray and not to the alpha and beta particles. The gamma ray of radium has a shorter wave length and is harder than the x-ray. It has been stated that it takes 26.5 cm. of soft tissue to absorb one-half of the gamma ray, while 4.9 cm. will absorb one-half of the x-ray. However, when radium is deposited in the body, the surrounding tissue is subjected to all three rays, but, because the quantity of radium present in any locality is minute, the action of the gamma ray and beta particle is probably negligible when compared to that of the alpha particle—95 per cent of the rays given off by radium are alpha particles. It has been estimated that 148 million alpha particles are given off per second for each milligram of radium present. It requires, according to the calculation of Swann (4), the impact of only one alpha particle on the nucleus of a cell to kill that cell, but fortunately most of the alpha particles escape into the blood stream in the form of emanations and are eliminated by means of the lungs. Probably 98 per cent of the particles escape in this manner. However, when the bone cell is hit by an alpha parti-

cle and killed, the calcium is absorbed, and finally an area of these absorbed cells is replaced by a fibrous process, as indicated by our histologic sections. The immediate surrounding tissue is devitalized, which accounts for the difficulty, if not impossibility, of stopping the necrotic process of the mandible so frequently present in the radium cases. It also explains the danger of any surgical intervention, as it simply opens the way for bacterial invasion with no healthy tissue to combat it. It is this factor which shows the difference between these cases and the jaw conditions in phosphorus poisoning, which it closely resembles in its gross appearance, and also explains why a sequestrum forms when local damage is done in treating conditions in the oral cavity with radium.

The process is slow in most cases and we have never found an increased calcium content in the blood. In the case of the girls, it may be of interest to note that they found relief from pain by taking calcium gluconate in preference to narcotics.

The association between radium and calcium is further indicated by a case of myositis ossificans progressive, in which I was asked to inject radium chloride. The patient was kept on a low calcium diet and the calcium excretion was determined for several weeks before the treatment began. After the injection of radium salts, an increased calcium elimination took place which decreased as the radium was eliminated. The progression has apparently stopped, as radiographs taken during the past three years (the last set just a few weeks ago) show no increase in calcification of the tissues. The question as to whether there has been any decrease in the calcium deposits is perhaps more difficult to determine, although there is more free movement of the limbs.

Further indication as to the devitalized condition of the cells in the skeleton is shown in the case of pregnant women who have worked at radium dial painting. Patients who showed no sign of decalcification previous to this condition, became crippled, and areas of decalcification

showed up rapidly after childbirth. No matter what treatment is given, it is impossible to get calcium redeposited, and the patient drifts into a more and more crippled condition. One case which I have recently seen is that of a girl whom I have watched for over nine years. At no time have I or anyone else who has been interested in the case, been able to detect more than 0.8 of a microgram of radioactivity in her body; a very small amount to have caused the damage. At the last examination she was apparently negative. She was married about four years ago, and has borne two healthy children. She is now crippled and radiographs of her skeleton show the "moth-eaten" areas we have found in so many of our cases. Rarefaction can be seen in other areas. It might be difficult to say definitely that she is a radium case; however, one cannot help but feel that she ought to be placed, at least, on the suspicious list.

Radium deposits in the body apparently have no effect on the germ cell, as healthy children are borne by these girls and there have been no abortions so far as I have been able to determine by questioning them or their doctors. The birth rate is normal. I have examined some of these children for radioactivity and in some cases have found them to be active. But it is always in cases in which the mother had ingested radium salts during the time she was carrying the child, or before the salt had been more or less mobilized in the skeleton. If the mother has been away from the industry for a year or so before becoming pregnant there is no sign of activity. I have been unable to keep track of all of these active children, but blood samples taken at the time of examination showed a tendency toward anemia.

All of the evidence given in this paper points to a destructive action of radium rather than to a stimulating one. All of our cases of sarcoma and those reported by Martland (many of which I have been privileged to test for radioactivity) contained less than 20 micrograms of radium, most of them, I believe, testing nearer ten.

For this reason, the destructive action is slow, a pathologic condition of the bone increasing with time. In most of the cases, I believe one can say that the sarcomas have appeared in the areas carrying the greatest stress.

This supervision consists of providing the proper medical and dental care, as well as compensation for practically all cases outside of New Jersey.

I wish to acknowledge my indebtedness to the many radiologists and other medical men who have lent me their assistance in this study, as well as to the Josiah Macy

Foundation who furnished funds which permitted the clearing up of certain points.

BIBLIOGRAPHY

- (1) MARTLAND, H. S.: The Occurrence of Malignancy in Radio-active Persons. *Am. Jour. Cancer*, 1931, **15**, 2436-2514.
- (2) SABIN, F. R., DOAN, C. A., and FORKNER, C. E.: The Production of Osteogenic Sarcoma and the Effects on Lymph Nodes and Bone Marrow of Intravenous Injections of Radium Chloride and Mesothorium in Rabbits. *Jour. Exper. Med.*, 1932, **56**, 267-289.
- (3) BIRD, C. E.: Sarcoma Complicating Paget's Disease of the Bone. *Arch. Surg.*, 1927, **14**, 1187-1208.
- (4) SWANN, W. F. G., and ROSARIO, C. DEL: The Effect of Radio-active Radiations upon Euglena. *Jour Franklin Inst.*, March, 1931, **211**.

PROTRACTED EXTERNAL IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE MOUTH AND THROAT

A COMPARISON BETWEEN X-RAYS, FIVE-GRAM PACK, AND SMALL RADIUM PACK¹

By IRA I. KAPLAN, M.D., MILTON FRIEDMAN, M.D., RIEVA ROSH, M.D., and CARL B. BRAESTRUP, B.Sc.

From the Radiation Therapy Service, Bellevue Hospital, New York City

THIS presentation is a preliminary report of clinical and laboratory work done in a further attempt to determine the comparative clinical values of radium and x-rays. The work was carried out in the Radiation Therapy Division of Bellevue Hospital as part of the regular therapeutic service of the Cancer Division, and with the assistance of a fellowship established through the courtesy of William R. Warner & Company, and Schering & Glatz.

Three distinct methods of irradiation were employed: high voltage x-rays generated at 200 K.V., a small 100-milligram radium pack, and a 5-gram pack. The latter radium was loaned to Bellevue Hospital by Radium Belge.

The physical measurements and experiments were carried out with special apparatus designed for this work, and the physical problems associated with this study were worked out by one of us (C. B. B.)

PURPOSE OF THE WORK

Two years ago, there were reported simultaneously two technics for treating neoplasms of the mouth and throat: one by Coutard, who advocated protracted external x-ray radiation, and one by Berven, who advocated protracted external radium radiation followed by endothermic incision and interstitial radiation. Berven said that empirical experience confirmed in his own and his co-worker's minds the superiority of radium over x-rays. Coutard did not specifically compare the two types of rays, but indicated in his report remarkable successes in the treatment

of pharyngeal, tonsillar, and laryngeal malignancies with x-rays, but did not offer a basis for clinical comparison because of the wide differences in technics. The lesions Berven treated were mainly of the radioresistant intra-oral types, and the external radiation was followed by endothermy and interstitial radiation. Those conditions treated by Coutard were the more radiosensitive lesions of the tonsil and hypopharynx, with the exception of the more resistant laryngeal growths. His cases were treated exclusively by external x-ray radiation. Nevertheless, each employed a ray of characteristic physical qualities which produced specific physical and biological effects.

Experimental radiotherapy is currently directed toward the application of rays of shorter effective wave length than those produced at 200 K.V. and 0.5 mm. copper filtration. By increasing the filter to 2 mm. copper (as employed by Coutard), the wave length is shortened from approximately 0.16 Ångstrom to 0.11 Ångstrom. With the application of gamma rays, wave lengths of the order of 0.01 Ångstrom are used. In order to produce these with the x-ray tube, a potential of more than a million volts would be required.

The laboratory's contribution to the study of the influence of wave length upon biological effect has been to present conflicting evidence. Packard exposed eggs of the *Drosophila melanogaster* to x-rays produced by potentials ranging from 12 to 500 K.V., with respective wave lengths of 1.7 to 0.02 Ångstrom. With the same number of r administered in the same period of time, he found no difference in the inhibitory powers of these rays on the various eggs.

¹ Read at the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.

Recently, Glasser and Mautz have disagreed with Packard's conclusions by demonstrating their own inability to standardize the *Drosophila* eggs. However, they deemed this medium suitable for approximate comparative measurements of the effectiveness of gamma and x-rays, and in their tests, conclude that different wave lengths produce different effects. Failla and his co-workers find that gamma rays are several times more destructive to *Drosophila* eggs than x-rays (200 K.V., and 0.5 mm. Cu filtration).

From these and other conflicting laboratory reports, it is impossible at the present time to draw any final conclusions.

PROCEDURE

We have attempted to study the problem of the influence of the wave length on the biological effect clinically. There were selected for treatment only those patients suffering from cancer of the mouth and throat. These cases offered for study three kinds of tissues of varying radiosensitivity: the skin, the mucous membrane, and the tumor itself, all of which could be continuously observed.

The three types of rays employed are produced with the following factors (See Table I):

1. *X-rays (Coutard Technic).*—K.V. 200, 4 ma., 2 mm. Cu and 1 mm. Al filtration, 60 cm. distance, 10 × 15 cm. portal (150 sq. cm.), duration of treatment, 21 to 30 days; time of each treatment, 40 minutes (average); two areas treated each day—one in the morning and one in the afternoon; total dose, 6,800 to 8,800 r ($3\frac{3}{4}$ S.E.D. to 5 S.E.D. to each area).




2. *Five-gram Radium Pack.*—Six mm. lead filtration, 6 cm. distance, 8 × 10 cm. portal (80 sq. cm.); daily dose, 5,000 to 7,500 mgm.-hrs. (only one area treated each day); total dose, 50,000 mgm.-hrs. (3 S.E.D.) to 60,000 mgm.-hrs. ($3\frac{1}{2}$ S.E.D.) to each area, when two areas are treated; 35,000 mgm.-hrs. (2 S.E.D.) to 45,000 mgm.-hrs. ($2\frac{3}{4}$ S.E.D.) to each area, when three areas are treated; grand totals, 100,000 mgm.-hrs. to 135,000 mgm.-hrs.

3. *Small Radium Pack—100 Mgm.*—Five mm. lead filtration, 6 cm. distance, 6 × 8 cm. portal (48 sq. cm.); time, 21 to 25 days; dose, 50,000 to 60,000 mgm.-hrs. to only one area.

PHYSICAL MEASUREMENTS

The physical factors of the different forms of irradiation were determined photometrically as well as by ionization meas-

TABLE I.—TECHNICS EMPLOYED

	X-rays 	Large Radium Pack 	Small Radium Pack 
	200 K.V. 4 ma.	5,000 mgm.	100 mgm.
Filtration	2 mm. Cu and 1 mm. Al	$\frac{1}{2}$ mm. Pt and 5 mm. Pb (6 mm. lead equivalent)	$\frac{1}{2}$ mm. Pt (5 mm. lead equivalent)
Distance	60 cm.	6 cm.	6 cm.
Portal	10 × 15 cm. (150 sq. cm.)	8 × 10 cm. (80 sq. cm.)	6 × 8 cm. (48 sq. cm.)
Daily dose	200–250 r to each of two portals	5,000–7,500 mgm.-hrs. to one area each day	2,400 mgm.-hrs. to only one area
Duration	21–30 days	25–35 days	21–25 days
Total dose	6,800–8,800 r to two portals ($3\frac{3}{4}$ –5 S.E.D.)	50,000 (3 S.E.D.)–60,000 ($3\frac{1}{2}$ S.E.D.) mgm.-hrs., when 2 areas are treated 35,000 (2 S.E.D.)–45,000 ($2\frac{1}{2}$ S.E.D.) mgm.-hrs., when 3 areas are treated Grand total: 100,000–135,000 mgm.-hrs.	50,000–60,000 mgm.-hrs. to one area

urements. Part of the work, "The Effect of Filtration and Distance upon Depth Dose," has been presented in a previous paper by Braestrup. A complete description of the physical investigation will appear in a subsequent paper now in preparation. For the present, we shall limit ourselves to a discussion of the results of the physical measurements as summarized (See Table II).

It will be observed that here are included not only the forms of irradiation used in the present clinical investigation but also the more common technics. This serves to illustrate the fundamental physical difference between the Coutard method and the usual forms of high voltage x-ray therapy.

By changing from 0.5 mm. of copper filtration to 2 mm. of copper the effective wave length is materially shortened by further elimination of the longer components of the x-ray spectrum. The half value layer is almost doubled, with a resulting improvement in depth dose of 3 per cent, while the increase in focal skin distance from 50 cm. to 60 cm. caused a 2 per cent depth dose gain in terms of the surface dose, making a total gain of 5 per cent in the depth dose. In terms of the depth intensity, the improvement is about 14 per cent by changing both filter and focal skin distance. However, to obtain these improvements in quality and depth dosage 75 per cent of the intensity is sacrificed, which must be compensated for by increasing the time.

Of particular interest is the small depth dose obtained with the radium pack. This, of course, is due to the short radium skin distance and, to a lesser extent, to the smaller field. A 6-cm. distance was selected for economical reasons, as well as to duplicate the technic used at Radiumhemmet.

The radium intensity of the radium pack was determined indirectly by photometric comparisons with a point source of known radium content. By this method errors due to the stray radiation from the pack were eliminated. The result indicated may be subject to minor corrections due to the wave length dependence of the thimble chambers used. It was found that in one hour, 480 r were given (about 8 r/min.). The clinical erythema dose administered in three and one-half hours was produced by 1,680 r.

TIME OF TREATMENT

The total irradiation was administered within a period of from 21 to 28 days. This period of time was selected for many reasons. First, when a full skin erythema dose is given in one sitting, with x-rays at 200 K.V., and with 2 mm. copper filtration, the erythema commences to subside on the twenty-first day. This is indicative of the destructive phase of the treatment, and the ascension of the healing phase. Associated with the healing phase, there occurs fibrosis and increased radio-resistance. It has, therefore, been necessary

TABLE II

Physical factors. The first section indicates the character of the x-rays, filtered with 0.5 mm. copper. This ray, which has been employed in the older technics, is described here for purposes of comparison

Filtration Field	Roentgen Rays Produced at 200 K.V.—4 ma. (puls. pot.)				Gamma Rays 5-gram radium pack
	0.5 mm. Cu + 1 mm. Al 10 × 15 cm.		2 mm. Cu + 1 mm. Al 10 × 15 cm.		0.5 mm. Pt + 5 mm. Pb 8 × 10 cm.
Distance	50 cm.	60 cm.	50 cm.	60 cm.	6 cm.
Intensity (in air)	13.2 r/min.	9.1 r/min.	4.96 r/min.	3.44 r/min.	7.94 r/min.
Quality H.V.L.	0.92 mm. Cu		1.8 mm. Cu		12.5 mm. Pb
Wave length	0.16 Å.		0.11 Å.		0.01 Å.
Depth Dose 5 cm. 10 cm.	65.4 per cent	67.9 per cent	67.0 per cent	69.6 per cent	26.5 per cent
	34.9 per cent	37.1 per cent	37.9 per cent	40.2 per cent	12.0 per cent

to administer all treatments before this occurred. Second, when a proper series of treatments has been administered accord-

mal tissues, and is followed by persistent epilation and other skin changes, destruction of the salivary gland function, osteitis

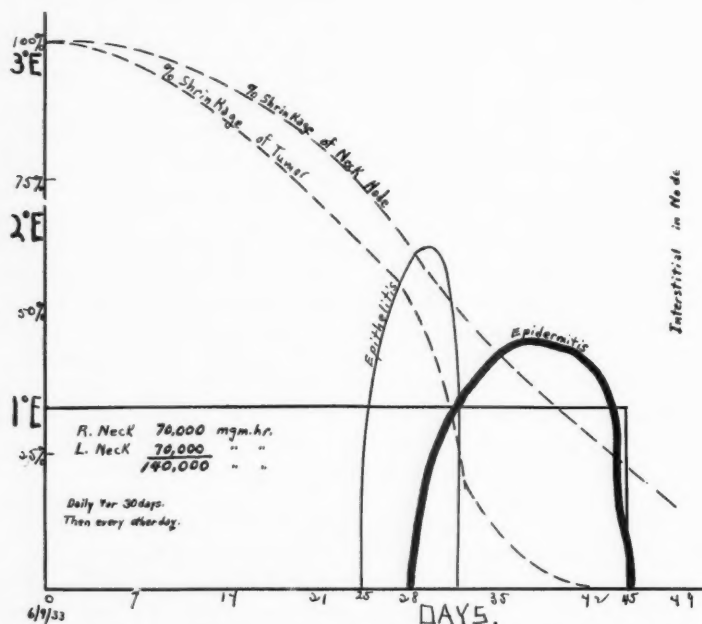


Fig. 1. This chart illustrates the inefficiency of treatments administered over too long a period of time. There is healing of the epithelitis and epidermitis even while the treatments are being administered. It also demonstrates the greater resistance of the neck nodes in comparison with the local lesion, even though their superficial location permits a greater depth dose.

ing to the exact Coutard technic, our experiences indicate that the average epithelitis first appears on the fourteenth to the sixteenth day, and commences to subside on the twenty-first day *even though treatments were being administered currently* (See Fig. 1). Thus there is noted a healing process of the mucosa even during the administration of the destructive rays. Third, our experiences coincide with those of Coutard, *i.e.*, if the duration of the treatments is shortened too much, there results an increase in the severity of the epithelitis and epidermitis, with a prolongation of these reactions. This necessitates a curtailment of the total dose administered. This prolonged reaction is significant of the excessive destructive effect upon the nor-

of the mandible, and continuous dry sore throat.

THE FIVE-GRAM RADIUM PACK

At the beginning of our work, we expected that when heavily filtered gamma irradiation was administered to the patient in such large doses as to produce in the same period of time equivalent biological reactions of epithelitis and epidermitis up to the point of lethal tolerance of the tissues, it would prove much more destructive to the tumor than x-rays through a greater selective action, due perhaps to the more intense Compton effect. This thought led to the construction of the 5-gram radium pack. Using a filter equivalent to 6 mm. lead, and an 8 × 10 cm. portal, at a dis-

tance of 6 cm., the threshold skin erythema dose was found to be 17,500 milligram-hours. The duration of each daily treatment of

in a busy clinic, many of whom were not very co-operative, has made it difficult to secure a standard time duration for the

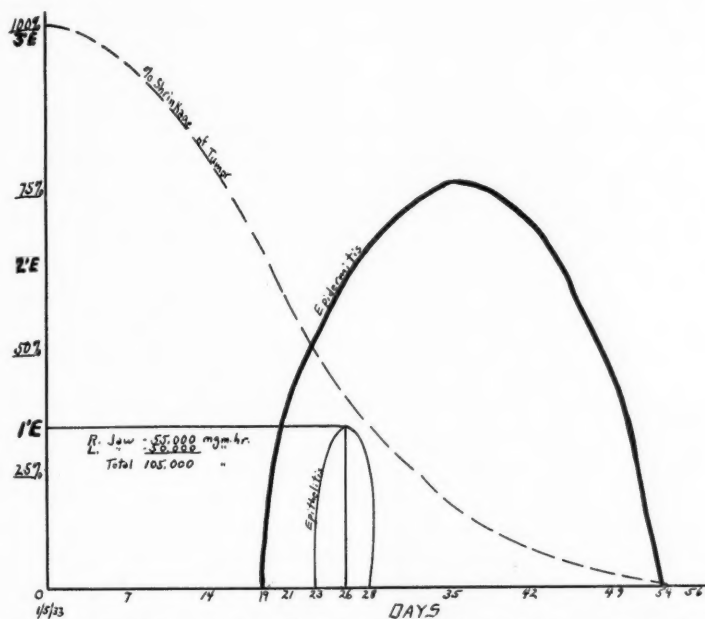


Fig. 2. Typical graph of clinical factors indicating time of treatment and intensity of epithelitis and epidermitis. This graph is constructed during the course of the treatments, entries being made weekly.

5,000 mgm.-hrs. was one hour, and was equivalent to 30 per cent S.E.D. daily. Only one of the two areas was treated each day, giving an average of 2,500 mgm.-hrs. to one area each day, as compared with 2,400-mgm.-hrs. to one area each day given by the small pack. When three areas were used, the daily dose was raised to 7,500 mgm.-hrs. in order to maintain this same daily average per field (Fig. 3-E).

In order to maintain close parallels in the various technics, we strove to employ the exclusive technic of protracted external radiation, thereby differing from Berven's technic in that interstitial radiation was not to be an integral part of the routine. Interstitial radiation and endothermic surgery were employed only in the event of a proved or anticipated failure. The necessity for treating a large number of patients

treatments. Because of complicating outside conditions, treatments were delayed in many instances, so that the average time for administering radium pack treatments has been 28 days as against 21 days for the Coutard technic.

Though this has made it difficult for accurate comparisons, it proved to be a happy accident. In a single skin test with the radium pack, the erythema appeared on the fourteenth day, and lasted for 14 days before it began to subside. The resolution of the destructive effect and the commencement of the healing phase from this exposure occurred on the twenty-eighth day. Thus all the radium pack treatments had been administered before fibrosis and increased radio-resistance had set in. In this period of 28 days, it required an average of 110,000 mgm.-hrs. total dose, or 55,000

mgm.-hrs. to each of two areas to produce a second degree erythema with superficial denudation of the epithelium (Figs. 2 and

erythema, and frequently becoming infected and forming abscesses. A late conjunctivitis with lacrimation, epilation

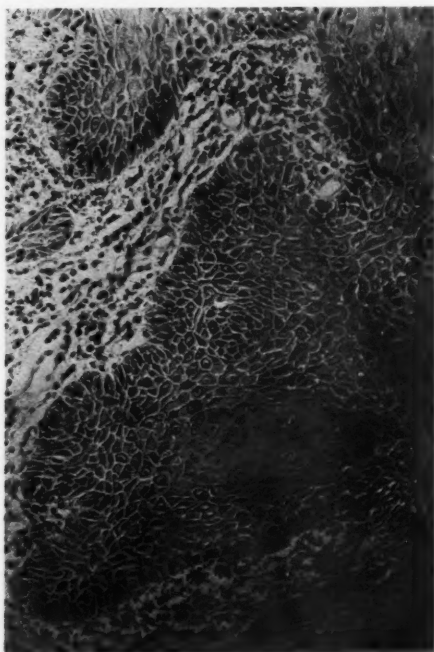


Fig. 3-A. Photomicrograph of tissue, Case 1, intrinsic carcinoma of the larynx, histologic Grade I. Patient was well ten months after the beginning of treatments.

3-E). The average duration of the epidermitis from such a dose was 32 days. The accompanying epithelitis was less intense than that produced by x-rays. However, when the gamma radiation was administered within 14 days, the epithelitis was of equal intensity to that produced by x-rays given in the same short period of time.

Because the gamma-ray beam is accurately delineated by the lead wall of the pack, the epilation is much less extensive than that produced by the small pack, in cases in which there is no protecting confinement of the gamma-ray beam. In addition, there were noticed other external reactions, such as multiple small sebaceous cysts, caused by the plugging of the necks of the ducts with desquamating epithelium associated with the severe second degree

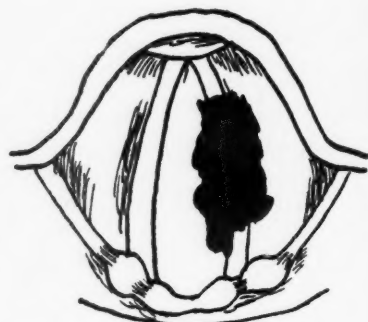


Fig. 3-B. Diagram of initial lesion, Case 1.

of the eyebrows and eyelashes, and marked photophobia requiring several months to abate may occur if the carcinoma is located on the roof of the mouth, in the nose, or sinuses, so that the high-placed beam of treatment rays includes the eyes in its path.

When the pack treatments are administered over a longer period of time than usual, which occurs when the patient is unco-operative and does not keep his appointments (a frequent incident among the ignorant poor with whom we have to deal), and a compensatingly larger dose is given, the mucosal reactions are not very intense, but the skin reactions extend over a much longer period of time, lasting sometimes as long as 60 days.

The intensity of the epithelitis is occasionally variable, when employing the same technic on similar cases, as a result of pyorrhea, misaligned and sharp-edged teeth. This is frequently seen as areas of excessively severe second degree epithelitis with denudation in a horizontal line on only those parts of the buccal mucosa which come in contact with the bad teeth. Therefore, we have concluded that it is wiser to delay the onset of treatment for from two to three weeks until mouth hygiene has been completed, rather than



Fig. 3-C. Case 1. Skin of neck on thirty-sixth day, showing reaction at its height.

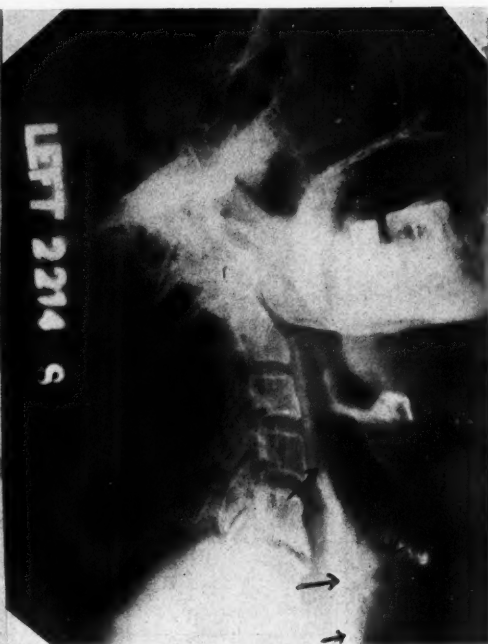


Fig. 3-D. Roentgenogram of larynx before treatment.

to be compelled subsequently to curtail the total quantity of radiation administered because of a too intense reaction in the oral mucosa.

General reactions from radiation were treated with Mead's viosterol.

SUBSEQUENT TREATMENT

Protracted external radium irradiation exhibits a profound effect upon the normal as well as the neoplastic tissues. This is particularly evident when interstitial radiation is employed. Residual tumor tissue subsequently treated by interstitial radiation may be completely destroyed and the surrounding area of healthy tissue, because of its fibrosed condition from the external radiation effect, will break down immediately or else a month or two later, and produce, along with the ever-present infection in the mouth, a rather intensive septic ulceration. This infected ulcer may last for months, and, in time, may even produce generalized metastatic lesions of

chronic sepsis. A mild radium osteitis may occur in adjacent bones, usually the mandible, so that further interstitial radiation or topical application of radium may cause an osteomyelitis which is more persistent and pernicious than that formerly seen. When such a condition is likely to occur, Berven's procedure of endothermic excision and interstitial radiation is carried out, except in a reverse order. It is our opinion that interstitial irradiation, even in small doses, of normal tissues already heavily irradiated from without prolongs the healing time and leaves a persistent, painful, infected ulcer. For this reason, we administer the interstitial radiation immediately after the acute reaction from the external irradiation has subsided. After an interval of one week, in order to permit some fibrous reaction of the tumor bed to take place, the tumor-bearing area is excised.

This excision must not only clean up the slough, but must also radically extirpate

the entire tumor-bearing area, a wide margin of heavily irradiated normal tissue, and all the infected bone down to the healthy

of this radiation has been administered, the tumor has not shrunk more than 50 per cent (a figure adopted empirically,

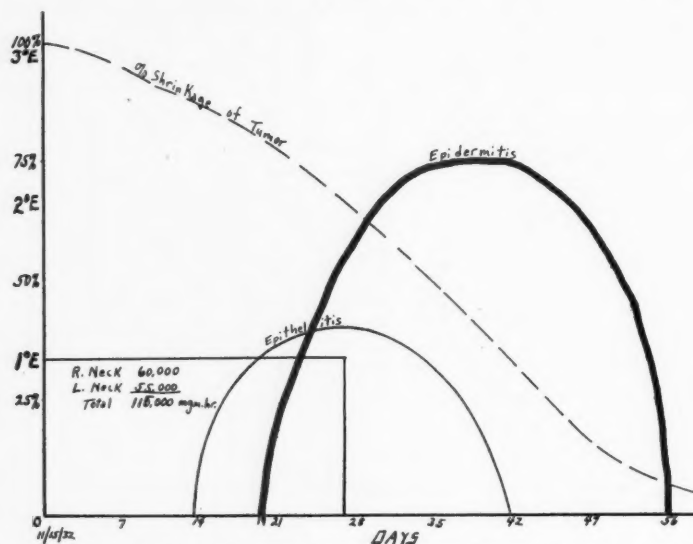


Fig. 3-E. Case 1. Treatment chart. (Five-gram pack, 0.5 mm., Pt + 5 mm., Pb filter, 6 cm. distance, 8 × 10 cm. portal.)

bone, even though partial resection of the mandible or maxilla may be necessary. This extensive post-radiation débridement and resection not only shortens the time of debility due to a prolonged radiation reaction, but contributes greatly to the eventual cure. Paradoxically, the more extensive the resection is, the quicker will the defect heal, and *vice versa*. From experience, we have learned of the inevitability of this resection. A persistent tumor which is irradiated interstitially is going to require endothermic excision sooner or later. If, by chance, it should heal spontaneously following interstitial radiation, it becomes fertile with complications, such as severe pain, recurrent necrosis, limitation of motion and function, and sepsis, all leading to a general debility of the patient and susceptibility to intercurrent infection.

To summarize the routine of radium treatment: First, protracted intensive external radiation. If, after two-thirds

and subject to change as experience dictates), then external radiation is immediately terminated and interstitial radiation carried out. This lesser amount of external radiation permits the tumor bed to react better to the subsequent interstitial radiation, and minimizes the debility from a painful epithelitis and epidermitis. One week after this interstitial radiation, if the patient's general condition permits, and there is no excessive edema and swelling of the tissues within the month, the tumor is excised. If, however, at the termination of the usual course of external radiation, there is a small residuum of tumor tissue, a very small dose of interstitial radiation is given, followed by endothermic excision. If the lesion has disappeared completely as a result of the external radiation, the tumor-bearing area is excised conservatively by endothermy, and no interstitial radiation given, unless the subsequent microscopic examination reveals the further presence of malignant tissue.

THE SMALL RADIUM PACK

The pack itself consisted of a hollow wooden box, 6×8 cm. square and 5 cm.

skin reaction and curtails the total dose permitted.

The treatment was administered in from 21 to 25 days, the dose varying between

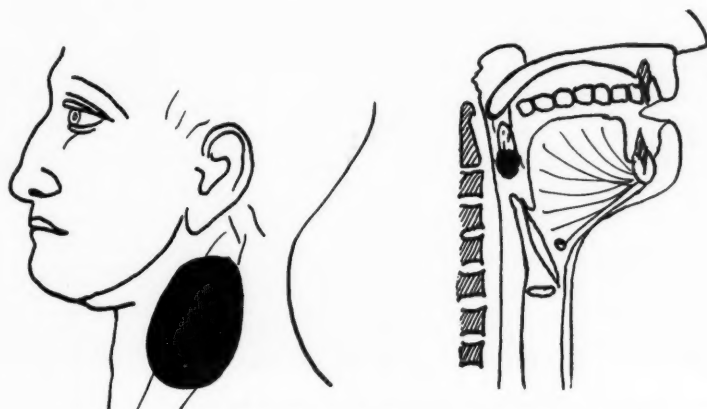


Fig. 4-A. Case 2. Carcinoma of pharynx (diagrammatic sketch).

high, to the top of which the radium was strapped. One centimeter additional compressed absorbent cotton was placed next to the skin, increasing the distance to 6 centimeters. This cotton avoids the compression necrosis which may appear during the last week of the treatment and which frequently aggravates the intensity of the 50,000 and 60,000 mgm.-hrs. over one area. Because of its form, an insufficient protection of the patient against scattered rays was afforded, and therefore the pack was applied only to one side of the neck. (See Fig. 4-F.)

The reactions to this form of treatment showed a fair degree of constancy. The epithelitis, which commenced about the seventeenth day, endured almost ten days. It was usually second degree in nature, being accompanied by soreness, redness, denuded areas in the mucosa, and fibrinous radium membranes. It was more intense in the mouth than in the throat, being aggravated by irritation of sharp teeth and pyorrhea. In many instances, focal areas of denudation of the mucosa could be seen around single teeth which were

either badly infected and decayed or else angulated so as to cut into the cheek. The fibrinous membranes would remain present for from 3 to 5 days and then rapidly disappear. Throughout the whole course of the treatment, the patient was seldom very uncomfortable from this reaction.



Fig. 4-B. Case 2. Mass in neck before treatment.



Figs. 4-C and 4-D. Carcinoma of the hypopharynx, with massive metastatic lymphadenopathy. The small pack is held in place with bandages. Note the healing of the skin in multiple small islands. The epithelitis from the small pack is usually not intense or prolonged. Figure 4-D shows condition on the forty-second day. Note epithelization progressing around small islands; also extensive epilation.

The epidermitis occurred with a slightly greater intensity commencing about the twenty-first day, upon the termination of the treatment, and during the middle of the epithelitis, so that the two reactions overlapped. The exact time of onset of the epidermitis was not infrequently confused by the erythema from pressure irritation due to the weight of the pack. The reaction would last from 3 to 4 weeks. At its height, there would be an area of denudation about 7 cm. in diameter, which healed in one week from multiple small islands in the center, indicating that the destruction had involved only the superficial epidermis, and not the germinal layer. There would be an extensive area of epilation of the hair of one side of the head, and a conjunctivitis and occasionally epilation of eyelids. This was due to the insufficient lead protection around the pack, which had to be of light weight in order that the patient might carry it around comfortably for the required twenty-one days. Following the treatment, the skin healed and became soft and

normal except for an occasional area of depigmentation.

While the stray radiation of the small pack made it inadvisable to apply it to more than one area, the large 5-gram pack with its heavily protected walls was readily applicable for treating two and occasionally three areas. In a few instances, however, the 5-gram pack was applied to only one portal, and it is from these reactions that we offer a tentative comparison of the nature of the cutaneous and mucosal reactions, but none concerning the effect on the tumor itself between this form of treatment and that of the small pack. On the basis of the evidence thus obtained, we are of the opinion that cutaneous 24-hour daily irradiation for from 21 to 25 days, up to a total of 50,000 mgm.-hrs. with the small pack, will produce an epithelitis and epidermitis equal to a dose of 60,000 mgm.-hrs. produced with the large pack given in units of one hour per day during the same period of time. Furthermore, the small pack with a total dose of 50,000 mgm.-hrs. directed through

only one portal was able to produce in several instances a profound effect upon resistant tumors with only slight local discomfort to the patient.

However, because the large pack has a portal twice the size of the small pack, this difference in reaction is somewhat lessened because the smaller pack confines its intense central radiation beams to a smaller area.

X-RAYS

From our clinical observations, we are of the opinion that there is a distinct difference in the effect of x-ray therapy when the filter used is changed from 0.5 mm. to 2 mm. copper, at 200 K.V. The lesser filtration produced a more severe degree of epithelitis with more extensive ulceration of the mucosa and fibrinous membrane formation. The soreness and dryness of the mouth and throat were more prolonged. This excessive reaction diminishes the total amount of radiation that can be administered to the patient. The largest quantity that we administered to any one patient, employing 0.5 mm. copper filtration, was 5,500 r, while with 2 mm. copper filtration, a total dose of 8,800 r was safely given. Though the number of cases in this group was small, there appeared to be less shrinkage of the lesion itself with the thinner filter. Coutard's preferential adoption of an increased filter indicates a like conclusion as to the biological superiority of the shorter wave length, based on his clinical experiences.

As Braestrup has shown, the greater the penetrability or quality of the ray, the higher the dosage in depth. With each increase in filter thickness, there is, therefore, an improvement in the depth dose. Yet, a point is soon reached where the fractional improvement is small and further increase in the filter thickness is not justified.

It is a known fact that an effective increase in the percentage depth dose can be accomplished, too, by an increase in the focal skin distance. Due, however, to the great increase in the time required to give



Fig. 4-E. Case 2. Healed skin, showing depigmentation.

the same dosage at the longer distances, we have learned that for practical purposes 60 cm. is the most applicable distance. This, too, is in accord with the Coutard technic which we have endeavored to duplicate.

In administering the protracted external x-ray therapy according to Coutard's outline, we have attempted no modifications. The factors used were: 200 K.V.; 4 ma.; 60 cm. distance; 2 mm. copper and 1 mm. aluminum filtration; 10×15 cm. portal; daily dose of 200-250 r to each of two portals; total dose 6,800-8,800 r. (See Fig. 5.)

It is a difficult feat to confine all the treatments to a period of approximately twenty-one days, but, with increasing experience, it becomes more evident that the slight variations in the number of days of treatment causes definite changes in the responses of the patient and his tumor. Effective protracted external irradiation constitutes a therapeutic barrage with only one round of ammunition which must be carefully aimed.

In this maze of inconstant biological factors with their innumerable variables, it is astonishing to note, as Coutard so brilliantly indicated, the close relation of the duration of the treatment to the time of onset of the epithelitis and epidermitis. A well-planned course of treatments given in twenty-one days will produce an epithelitis commencing on the eighteenth day, and terminating on the twenty-sixth day, at which time the epidermitis commences.

If the treatments are administered in a shorter period of time, the two reactions overlap. If given over a longer period of

treatment is one that will produce consecutive reactions, the epidermitis commencing as soon as the epithelitis has subsided.

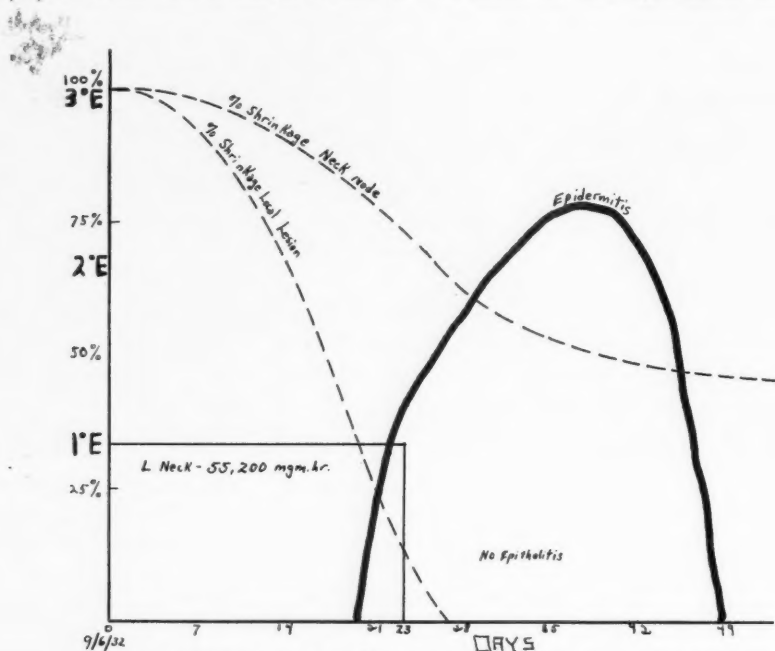


Fig. 4-F. Chart of Case 2. Technic: 100 mgm. radium pack, 6 cm. distance, 2.5 mm. Pt filter, 6 × 8 cm. portal.

time, the epithelitis and epidermitis are of lesser intensity and are separated by a definite time interval. Increasing the total dose, as we have done on occasion, above 8,000 r when the treatments had been unavoidably dragged beyond twenty-one days, does not seem to influence the character of the reactions or the response of the tumor. Our experiences and those of Coutard confirm this theory, especially when applied to the administration of a second series of external x-ray treatments. Consequently, we do not recommend this repetition except where no alternate therapy is available, such as in carcinoma of the larynx. In a carcinoma of the tonsil, however, we have found a second series of external irradiation with x-rays much less effective than interstitial radiation and endothermic surgery.

Coutard says that the best regulated

Our best effects were secured in those cases in which there was an overlapping of the reactions for a period of from 5 to 7 days. If the treatments are given over too long a period of time, *i.e.*, from 30 to 35 days, the reactions are late in appearing; the epithelitis usually healing, and then, after an interval of a few days, the epidermitis appearing. The soreness from the epithelitis was mild and frequently did not appear. The skin reaction was not very severe. This sparing of the patient and the hurdling of the obstacle of intense debility of the patient during the time of the reaction deludes one into choosing the prolonged schedule of treatments, but it should be remembered that the mildness of the reactions and their tardiness in appearing may be due to the increased resistance of the tissues as a result of the desmoplasia of the healing phase. There is a

coincident attenuation of the virulence of the neoplasm with an increased radio-resistance. Increasing the total dose much

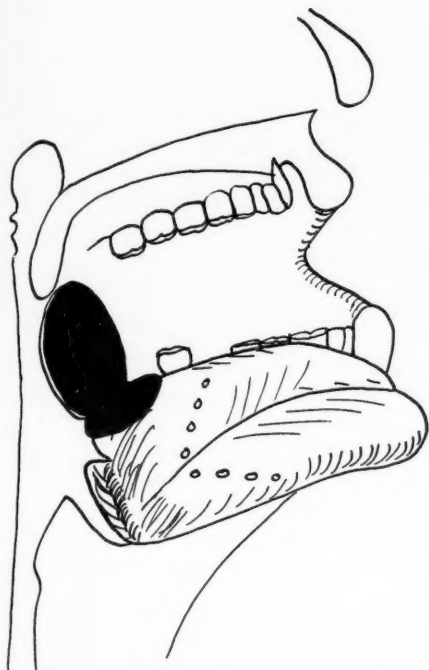


Fig. 5-A. Case 3. Drawing, showing location of cancer of the tonsil.

above 8,000 r serves very little to intensify these reactions or the effect upon the tumor. It is consequently, in our opinion, of great importance to avoid extending the treatments into the healing phase.

In comparing the effect of the x-rays with the gamma rays, we were surprised to note the similarity in action of these two rays on the skin and mucosa. The number of cases are too few to permit comparison of their effects on the tumor, but to date, there appears to be no appreciable difference. Interstitial radiation following x-ray therapy is more comfortably tolerated by the patient and the local tumor bed, there being less pain, fewer sloughs, and less intense bone complications.

CONCLUSIONS

1. In employing x-rays and gamma rays



Fig. 5-B. Carcinoma of the tonsil treated with the Coutard technic. Skin reaction was not very severe, due to the low total dose. Interstitial radiation was well borne. The photograph shows the reaction at its height (32 days).

in a manner similar to the technics outlined by Coutard and Berven, respectively, we find that early observations indicate a similarity in their effect upon the tumor.

This seems to indicate that the shorter wave length of the gamma rays compensates in effectiveness for the relatively low depth dose obtained with the radium pack at 6 cm. distance. In order to take advantage of any superiority of the radium pack, it will be necessary for us to increase the treatment distance considerably above 6 cm. in order to improve the depth dose. The benefit to be derived from this step may justify its increased cost.

2. The duration of the period of administration of treatment is the most important factor in protracted external irradiation. Each type of neoplasm has its own rhythm of response which must be paralleled by an optimum time duration of the treatments. Furthermore, each type of radiation has a characteristic period of greatest effectiveness, during which the destructive phase is in the ascendancy and the healing phase has not yet commenced. The proper delicate adjustment of these two factors is essential to efficient protracted radiation.

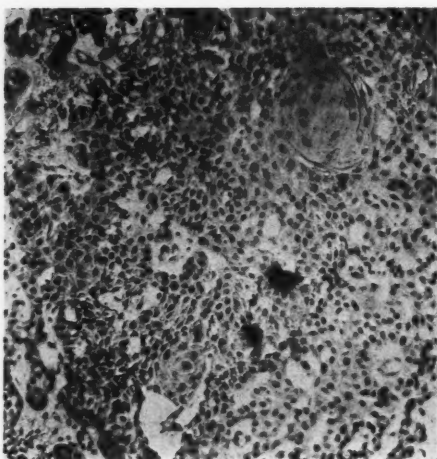


Fig. 5-C. Case 3. Photomicrograph of tissue (squamous-cell epithelioma, Grade II).

3. The small 100-mgm. radium pack is an efficient therapeutic medium which can closely rival the large 4- and 5-gram packs.

4. Gamma rays produce a more profound effect upon the normal tissues around the tumor than x-rays, rendering them less well able to withstand subsequent interstitial radiation.

5. When the filtration of 200 K.V. x-rays is raised from 0.5 to 2 mm. copper, there ensues a less intense epithelitis and epidermitis.

6. Maximum tolerances over the same period of time and producing similar reactions occur with from 3 to $3\frac{1}{2}$ skin erythema doses with the radium pack, and from $3\frac{3}{4}$ to 5 skin erythema doses with x-rays filtered through 2 mm. copper.

7. The above conclusions are offered tentatively, as they are based upon a preliminary report of observations extending over a period of only one year.

CASE REPORTS

Cancer of Larynx.—Case 1. White male, aged 54, apparently healthy; a slightly hoarse voice; no palpable neck nodes. Indirect laryngoscopic examination is difficult. Direct examination shows a small ulceration on the right vocal cord.

X-ray examination of the larynx shows neoplastic infiltration of the larynx at the level of the cricothyroid cartilage, mainly in the posterior wall of the larynx, resulting in the elevation thereof and of the superimposed soft structure.

The history as taken Nov. 14, 1932, is as follows: The onset occurred six months previously with hoarseness which gradually grew worse. Biopsy taken previously showed epidermoid carcinoma. The patient felt better after the biopsy, but soon began to grow worse. There was no dysphagia or pain.

The histologic examination on Oct. 17, 1932, showed epidermoid carcinoma, squamous-cell type, Grade I.

There was external radiation with the five-gram radium pack, the technic being as follows: 0.5 Pt plus 5 Pb filter, 6 cm. distance, 8 by 10 cm. portal; two areas, right and left larynx—one area treated each day for one hour, giving a dose of 5,000 mgm.-hrs. From Nov. 15, 1932, to Dec. 12, 1932 (30 days), treatments were given. The dose to the right larynx was 60,000 mgm.-hrs.; to the left, 55,000 mgm.-hrs., or a total dose of 115,000 mgm.-hrs.

The reaction was as follows: On the *fourteenth day*, a slight increase in hoarseness; on the *twenty-first day*, beginning erythema of neck, slight edema of arytenoid, pain; on the *thirtieth day*, beginning denudation of skin, soft tissue edema of neck, marked hoarseness and dysphagia; on the *thirty-sixth day*, islands of beginning healing in the denuded area, voice better, faint dullness of mucosa of larynx, no edema of cords; on the *fifty-sixth day*, skin of the neck healed, dysphagia gone, vocal cords clear; at *four months*, lack of taste, persistent slight submental edema.

On Sept. 22, 1933, the lesion was pronounced healed. (See Figs. 3-A to 3-F.)

Cancer of the Pharynx.—Case 2. Physical examination shows a large mass, somewhat movable, in the left neck, measuring 5×7 cm., composed of several nodes adherent to one another. The local lesion is a small, flat, nodular induration, 1.5 cm. in diameter, in the lower left tonsillar fossa.

It extends for three-fourths of a centimeter on to the base of the tongue, and is not very distinct from the surrounding tissues.

The history as taken Sept. 6, 1932, is as follows: The onset occurred seven weeks

to measure $2 \times 2 \times 2.5$ centimeters. Eleven radon seeds were inserted; the dose given was 2,783 millicurie-hours.

Progress was as follows: Subsequently, in the same area several new nodes ap-

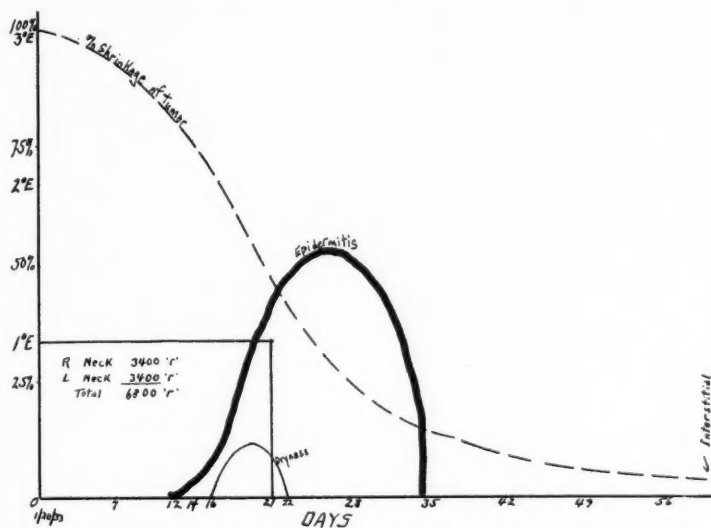


Fig. 5-D. Chart of Case 3. Technic: 200 K.V., 4 ma., 2 mm. Cu, 60 cm. distance.

previously, with a small node in the left neck which has grown larger.

The histological examination as taken on Aug. 24, 1932, is as follows: A plexiform epithelioma of the spindle-cell type.

External radiation was given as is shown in Chart 4-F.

The reaction was as follows: The throat was very comfortable; no epithelitis. The local lesion healed on the twenty-seventh day. The large neck node increased the distance of the radium from the lesion by 3 cm., which may have accounted somewhat for the absent epithelitis. There was second degree epidermitis; denudation did not involve the germinal layer of the epithelium; healing occurred from multiple islands of regeneration (Fig. 4-D).

Interstitial radiation was given on Jan. 12, 1933, the one hundred and thirty-sixth day. Under local anesthesia, the neck node was exposed by an incision and found

peared which did not respond to further treatment. (See Figs. 4-A to 4-F.)

The patient died on June 7, 1933.

Cancer of the Tonsil.—Case 3. The history as taken on Jan. 20, 1933, is as follows: A sore throat started one month previously; at present, there is pain on swallowing and slight fixation of the tongue.

Examination shows the following: Over the left tonsil there is a flat growth which covers it entirely, and extends on to the left posterior border of the tongue. The tonsillar part measures $2.5 \times 3 \times 0.5$ centimeters. It is the same color as the surrounding tissues, and is very hard. The left glossotonsillar groove is obliterated. The extension on the tongue measures $2.5 \times 2.5 \times 0.5$ centimeters: The lower border of this part is 0.5 cm. above the tip of the epiglottis. The patient's age was 59 years.

External irradiation was as follows: X-ray, 200 K.V., 4 ma., 10×15 cm. portal, 2 mm. Cu and 1 mm. Al, 60 cm. distance, 200 r = 36 minutes. From Jan. 20, 1933, to Feb. 10, 1933, 17 treatments were given to each side of the neck, covering two areas a day, at 200 r to each area, making a total of 3,400 r to each area, and a grand total of 6,800 r.

The reaction was as follows: Erythema started in 10 days, at which time the lesion had shrunk to 60 per cent of its original size. On the twenty-second day (last treatment), both necks were fiery red, and there was a superficial scab on the right side. The patient was resting comfortably. The lesion was 25 per cent of its original size; there was no distinct epithelitis, just a faint dullness of the mucosa. On the twenty-sixth day, there was only a slight scab on the ears. The mouth and throat were dry; there was no taste or limitation of motion of tongue.

Histologic examination showed the following: Squamous-cell epithelioma, Grade II.

Interstitial irradiation was as follows:

On Feb. 21, 1933, occurred the peak of the recession. There was only slight residual induration present. On March 9, 1933, there was a slight recurrence. On March 17, 1933, recurrence reached one-half its original size. Eight gold radon seeds of 0.2 mc. each were inserted into the lesion. The dose given was 212 millicurie-hours.

Reaction was as follows: On April 21, 1933, the lesion shrank a little, only to enlarge again. Interstitial radiation was given of 10 gold seeds; dose, 1,356 millicurie-hours. On May 13, 1933, the lesion was healed, after a painful reaction which lasted for three weeks. On July 3, 1933, there appeared a small crater with suspicious edges. Interstitial radiation of 8 gold seeds was applied; dose, 1,600 millicurie-hours.

Progress was as follows: On Aug. 1, 1933, the lesion had healed except for a small remaining radium membrane. On Sept. 5, 1933, there was secondary breaking down of the area, with the formation of a crater filled with slough, which was painful and debilitating.

CASE REPORTS AND NEW DEVICES

A CASE OF HEMANGIO-ENDOTHELIOMA¹

By CHARLES H. DEWITT, M.D., *Valparaiso, Indiana*

The report of William H. Teller, M.D., Leon Solis-Cohen, M.D., and Samuel Levine, M.D., in the March number of *RADIOLOGY*, prompts me to report a somewhat similar case, since the progress of my case may help to answer the problems suggested in the last paragraph of their report.

Miss E. W., aged 55 years, first came under my observation on Nov. 20, 1926. She had a somewhat nodular growth, with several ulcerated areas which bled occasionally, about 6 cm. in diameter and 5 cm. in depth, over the crest of the left tibia in the middle third.

She stated that the growth, which started about twenty years previously, was then a firm, reddish nodule, and not painful. At the onset, it increased in size very slowly, but had been more rapid during the last few months, causing her considerable pain when walking and standing.

Unfortunately, the original roentgenograms are not available, but there was no involvement of bone, although the tumor extended to the periosteum of the tibia.

I made a probable diagnosis of epithelioma, and as the patient refused operation, I gave her x-ray therapy with moderate voltage, and the tumor entirely disappeared. A specimen removed for microscopic study was reported as hemangio-endothelioma.

Figure 1 shows the condition two months after treatment. The excavation of the tibia is the result of the removal of thin plates of bone, due to the fact that the bone was exposed for several weeks until it was finally covered by granulation tissue.

One year after treatment, a small reddish nodule, which appeared 2 cm. below the margin of the original growth, responded readily to radiation. At intervals, several similar nodules which appeared outside the area of the original growth, disappeared after radiation.

On Nov. 10, 1933, she reported for another examination, and there was at this time the first evidence of recurrence in the area of the original growth. In addition, she also had one firm enlarged left inguinal node, and complained of pain in the lumbo-sacral region. However, there was no x-ray evidence of metastasis.



Fig. 1.

The patient moved away, and I did not see her after Nov. 10. She died a few months later, and it was reported that she had severe pain in the right shoulder, with considerable coughing which lasted for several weeks prior to her death.

UNUSUAL ACTION ON THE PART OF A FOREIGN BODY¹

By WILLIAM J. CORCORAN, M.D., F.A.C.R.,
Old Forge, Pennsylvania

On April 15, 1926, L. P., a male, aged 41 years, was shot in the back. An x-ray examination made the same day revealed the bullet lying between the bodies of the fourth and fifth lumbar vertebrae (the patient has six lumbar vertebrae (Fig. 1). Neither the antero-

¹ Accepted for publication July 9, 1934.

¹ Accepted for publication June 25, 1934.

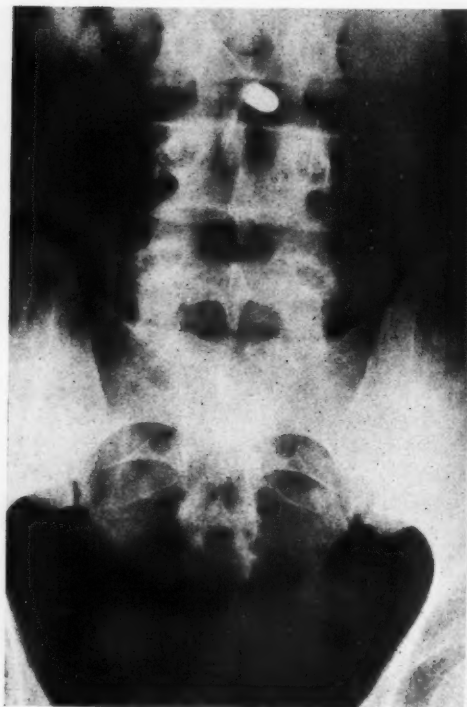


Fig. 1.



Fig. 2.

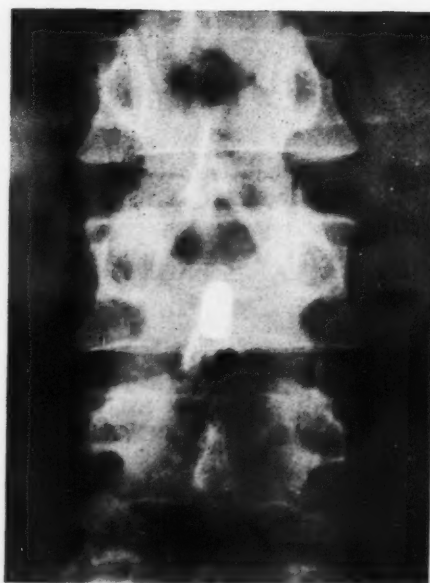


Fig. 3.

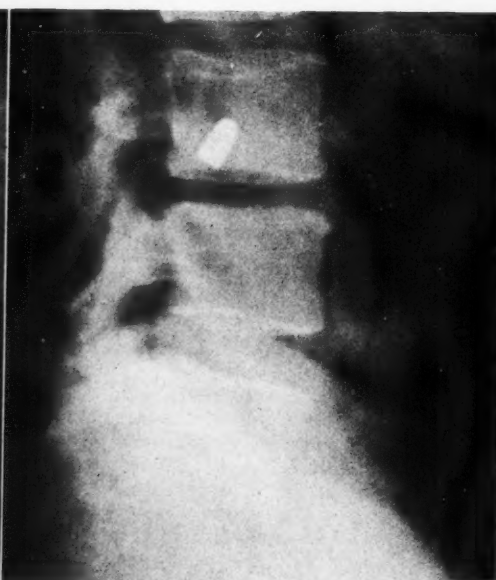


Fig. 4.

posterior nor lateral views disclosed evidence of injury to the bodies. The lateral view (Fig. 2) showed the rounded end of the bullet to lie forward and downward. The patient was completely paralyzed in both legs for several days, function gradually being restored to the extent that he was able to walk in two months with the use of canes. In a few more months, he was able to discard these, but always had a wabbling gait and for several years was unable to walk more than three blocks at one time.

Eight years later, he was seized with severe pain, intermittent in character, lasting several weeks. On Feb. 3, 1934, he appeared for an x-ray examination. Anteroposterior and lateral views (Figs. 3 and 4) showed the bullet within the body of the fourth lumbar vertebra. A calcified pathway just below the bullet could be seen on the anteroposterior view. The bullet is apparently lodged safely and securely, producing practically no pain. At this writing, June 18, 1934, the patient feels better than at any time during the past eight years.

Many interesting cases have been reported showing unusual action on the part of foreign bodies. It is not often that one sees this in the case of bony structures, even though it be the spongy part that is invaded.

REPORT OF TWO CASES OF DIAPHRAGMATIC HERNIA

By JAMES J. QUINEY, M.D., *Easton,
Pennsylvania*

Case 1. Mrs. J. S., aged 65 years, a widow, was referred for gastro-intestinal examination on Dec. 8, 1930, with the suggestion that a pyloric obstruction existed.

The patient was well nourished and had a good appetite, but her complexion was sallow, she was extremely nervous, and complained of a persistent unproductive cough which at times interfered with sleep.

She stated that she had lost 10 pounds in the preceding six months, belched quantities of gas, and that her symptoms were aggravated by the intake of any kind of food. She complained of pain, but there was no tenderness at the site of a large abdominal scar resulting from a cholecystectomy and hysterectomy performed 15 years earlier.

A meal administered six hours previous to the fluoroscopic examination was found in the terminal ileum. Following it through by means of the fluoroscope, it was determined that the opaque meal passed through the esophagus and into the stomach in a normal manner. As the stomach filled, it appeared



Fig. 1. Note the constricted and puckered appearance of the stomach at the junction of the upper with the mid-third.



Fig. 2. The leaves of the diaphragm are seen, the plane of the left leaf corresponding to the constricted area of the stomach.

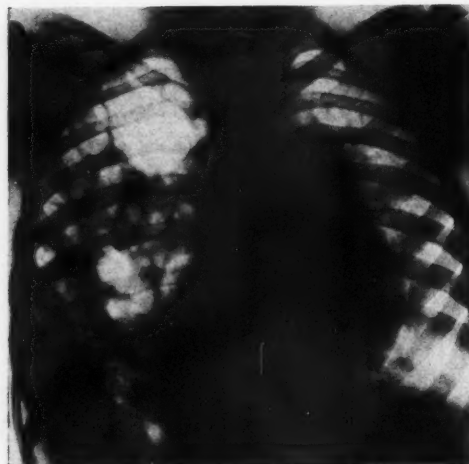


Fig. 3. The loculated air-containing areas are separated by thin septa. The heart, trachea, and bronchi are displaced to the right. The left dome of the diaphragm cannot be seen.



Fig. 4. The same after ingestion of the barium meal.

shortened in its long diameter. The addition of a barium meal revealed gradual narrowing of the stomach at its upper pole and constriction, with a puckering of the stomach walls, above which it broadened out to normal dimensions. It was also noted that, as the upper segment filled, the food descended through the esophagus in a normal manner to its lower portion and then described a U-turn, the distal portion of the U entering the stomach on a higher level than the base of the U. The domes of the diaphragm were plainly seen below the upper segment of the stomach. The heart was but slightly displaced, if at all.

A diagnosis of hernia of the stomach through the hiatus esophagi was made.

Later, when this patient was again subjected to roentgen examination, a perfectly normal stomach occupying a normal position was found. In arriving at a more complete diagnosis, resort could have been made to the administration of an effervescent drink, which would have resulted in a filling of the segment above the diaphragm with gas, through which the basal lung markings could have been seen.

Case and Upson¹ state that spontaneous reduction of a diaphragmatic hernia prior to examination is not infrequent and that it is thus rendered elusive. These authors report a case demanding immediate operative intervention. They also call attention to the effect of

straining after inspiring. The diaphragm and liver are thus forced downward, giving a better view of the lower end of the esophagus. The Trendelenburg position is advantageous in arriving at a definite conclusion. They also state that the stomach is the first organ to enter the chest through the hernial opening.

Hedblom, quoted by the above authors, reported 343 cases in which the contents of the hernia were stated: in 94, the stomach was the only hollow viscus involved; in 101, the colon and small intestine were implicated, in addition to the stomach, and, in 86, bowel alone was found in the hernia.

Case 2. Z. S., aged 4 years, was referred May 12, 1931, for x-ray examination of the chest. A diagnosis of pleurisy with effusion had been made.

Films and fluoroscopic examination showed a loculated shadow on the left side. The loculi, which contained air, were separated from one another by very thin septa. The heart, trachea, and bronchi were displaced far to the right. The diaphragm on the left side could not be seen. Additional films made following the ingestion of a barium meal revealed the stomach in normal position. The loculated areas were partly filled with barium. It is interesting to note that the intestine extended well up to the apex on the left. The evidence indicated a hernia of the diaphragm, and as no history of traumatism could be elicited, it was considered congenital.

¹ Roentgenologic Aspects of Various Types of Hernia. Jour. Am. Med. Assn., Sept. 18, 1926.

In these cases a diagnosis of pleural effusion is not unusual. One writer reports a case of an infant upon whom paracentesis was done and a flow of milk occurred through the needle, showing that the intestine, which had herniated through the diaphragm, had been perforated.

It would be of interest to know whether, in the case above reported, a hernial opening exists in the diaphragm or the left leaf of the diaphragm is absent.

SYMPTOMLESS CONGENITAL DUPLICATION OF THE LUMBOSACRAL SPINE¹

REPORT OF A CASE

By JOHN S. BOUSLOG, M.D., and ARTHUR
ESSERMAN, M.D., Denver, Colorado

Although the literature on vertebral anomalies is replete with reports of numerical variations, a careful review of the material has failed to reveal another case similar to the one reported here. It is generally conceded that the lumbosacral region is the most frequent site of vertebral anomalies. Also, spina bifida and supernumerary vertebrae are common, but the latter always occur in the line of the vertebral column (not laterally, as in this case), and the former, properly defined, denotes a failure of the bone to unite over the neural arch. Therefore, the case which motivates this report does not belong in either of those two categories, nor, insofar as we are able to determine, to any other special group.

On Oct. 3, 1932, O. M. C., negro female child, aged nine years, was brought to the Children's Hospital, Denver, by her father because of an acute gastro-intestinal disturbance which proved to be typhoid fever. The patient was the youngest of six children, all the rest of whom (one boy and four girls) and the father were living and well. The mother had had eighteen miscarriages, which had occurred at intervals scattered throughout the six live births. The patient had always been considered frail, and there had been chiropractic treatments.

In the course of the physical examination, the unusual appearance of the patient's back was noted. It looked as if there were a shelf of bone between the ilia and the lower ribs. This seemed to extend bilaterally away from the spinal column. Aside from sluggishness of the left knee jerk, all the reactions were normal.

Roentgen Examination.—Roentgenograms of the lumbar and sacral vertebrae revealed anomalous development of the lower lumbar

and sacral segments. The anteroposterior view showed a broad second lumbar vertebra, the lower surface of which was V-shaped, to permit articulation with the bodies of the two third lumbar vertebrae. There were two third, two fourth, and two fifth lumbar vertebrae, and two complete sacra. Only the first segment of the coccyx was present. On the right side, the bodies of the third, fourth, and fifth lumbar vertebrae were fused together, and formed a single osseous mass. Also, the right fifth lumbar vertebra was fused across to the left fifth lumbar vertebra and the left sacrum. Medially, the two sacra articulated with one another. The lateral transverse processes of both sets of the third, fourth, and fifth lumbar vertebrae were present and of average size. The medial transverse processes of the fourth and fifth lumbar vertebrae were vestigial in type, small and somewhat deformed. There was no medial transverse process on the left third lumbar vertebra. Both sacro-iliac regions appeared normal as were all the rest of the vertebrae. The lateral roentgenograms showed no anterior or posterior disalignment. The diagnosis was: congenital anomaly (duplication) of the third, fourth, and fifth lumbar vertebrae and the sacrum.

COMMENT

From the foregoing report, it is readily seen that the vertebral anomaly in this patient is a rare, and in all probability, a singular one. It certainly does not belong to the category of spina bifida because the characteristic features are not failure of union of the parts of the vertebrae, but rather a duplication of certain segments.

Among the reports of anomalous vertebral development, the only cases which even partially parallel ours were those in which Brailsford (1) stated that Bowman noted a lack of sacrum and coccyx, and also those in which these portions of the spine were almost a shapeless mass. Brailsford also quoted Decker as describing "a sixth lumbar vertebra, with a spine which split into two unequal portions and an articular surface between." The condition which exists in the third lumbar vertebra of our patient may be similar to the one mentioned by Decker.

Willis (2) said, "the lumbar portion of the column adjacent to the sacrum presents certain morphologic defects, described as bifid and separate arches.... The bifid arch is due to arrest of development before fusion of the laminae takes place, the separate arch to irregular ossification with interruption of bony continuity."

¹ Accepted for publication June 20, 1934.



Fig. 1. Roentgenogram of the lumbar and sacral spine.



Fig. 2. Sketch of the same.

All of the authors studied concur in the statement that the lumbosacral region is the one which is most often the site of anomalous development. Willis (3) also found that although the data were insufficient for conclusive deductions, in 1,471 skeletons, as regards vertebral variability, there is a slight excess of the females over the males and of the negro over the white. He also found that there is a more marked tendency to lengthening than to shortening of the column.

Etiologically, the condition we report may be similar to those anomalies which result in separate neural arches, and it may belong to either the monster group or it may be of embryonic origin.

SUMMARY

A case of duplication of the third, fourth, and fifth lumbar vertebrae and all of the sacral segments of the spine, and broadening of the second lumbar vertebra, is reported. The patient is a negro girl. This seems to be the only case of its kind on record.

BIBLIOGRAPHY

- (1) BRAILSFORD, J. F.: Deformities of the Lumbosacral Region of the Spine. *British Jour. Surg.*, April, 1929, 16, 562.

- (2) WILLIS, T. A.: The Lumbosacral Vertebral Column in Man: Its Stability of Form and Function. *Am. Jour. Anat.*, July, 1923, 32, 95.

- (3) IDEM: An Analysis of Vertebral Anomalies. *Am. Jour. Surg.*, February, 1929, 6, 163.

CHRONIC DUODENAL STENOSIS IN THE ADULT

REPORT OF A CASE WITH A RESULTING SECONDARY DEFICIENCY SYNDROME

By CLIFFORD R. WEIS, M.D., F.A.C.P.,
Dayton, Ohio

From the Medical Service of St. Elizabeth Hospital,
Dayton, Ohio

Chronic duodenal stenosis is caused by a number of distinct pathologic processes which may involve the first, second, or third portion of the duodenum. For convenience, it may be divided into the following classification:

- (A) *Intrinsic Causes*.—(1) Abnormalities of shape or position; (2) acute and chronic duodenitis; (3) hypertrophy of the valvulae conniventes; (4) congenital narrowing; (5) benign and malignant tumors; (6) ulcer; (7)

pressure of diverticula; (8) foreign bodies; (9) localized hypertrophy of the muscle layer.

(B) *Extrinsic Causes*.—(1) Pathologic

with a glove-like distribution, and pigmentation suggestive of a deficiency diet.

Case 1. C. W., male, aged 46 years, an



Fig. 1. Showing greatly distended stomach and duodenum.

changes in normal attachment; (2) congenital bands; (3) gall-bladder inflammation; (4) ptosis of right kidney; (5) gall-bladder adhesions and gallstones; (6) constriction of the duodeno-jejunal opening; (7) anomalies of the pancreas (by hypertrophy, abscess, tumor, bands, and annular pancreas); (8) pressure from aneurysm, enlarged glands, and tumors; (9) prolapse of the colon and small intestine, with or without arterial compression through the superior mesenteric artery or its mid-colic, right-colic, or ileo-colic branches; (10) compression of the prolapsed jejunum at the pelvic brim.

The case herein reported showed a stenosis of the second portion of the duodenum, probably due to progressive duodenitis of six years' duration, anemia, a dermatitis of the hands

American machine hand, was referred by Dr. E. J. Duffy because of vomiting during the past six months, which had become so frequent that at the present time he could tolerate only fluids.

There was no relation of the vomiting to meals, nor was the pain or previous history suggestive of gastric or duodenal ulcer syndrome. The patient noticed on frequent occasions that he regurgitated food eaten several days before, and that it had a very offensive odor, reminding him of "sewer gas or carbide." Six years previously, he began to have attacks of vomiting not related to meals, no accompanying pain, but with much gas and gastric distress. For two years the attacks occurred about once a week, gradually coming on more frequently until, beginning six months ago,

they occurred as often as several times daily. During this time the diet was inadequate; he ate few fruits and vegetables, subsisting al-

tissue turgor was poor and both ankles were swollen; both superficial and deep reflexes were normal; no superficial lymph glands were

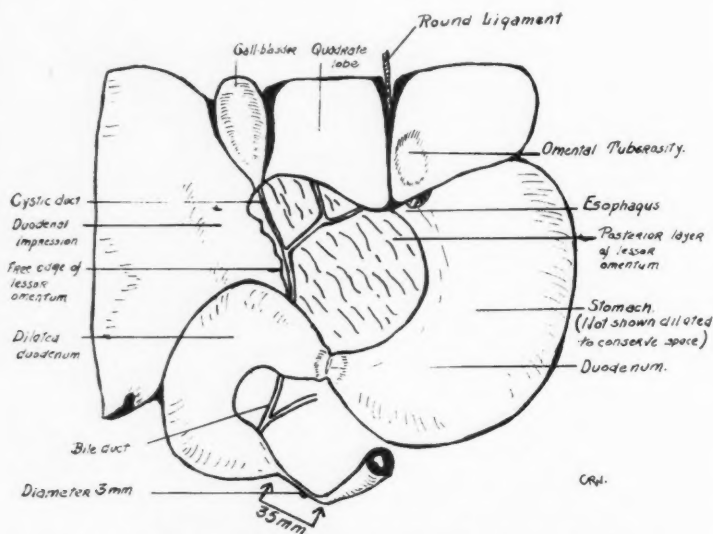


Fig. 2. Diagrammatic sketch, showing site of the duodenal stenosis.

most entirely on fluids. As a result, there was progressive loss of weight and an eruption appeared on both hands up to the wrist line. A factory physician, whom he had consulted, told him that he had anemia, a few days later the patient collapsed while at work.

At this time he was referred by Dr. E. J. Duffy for a diagnostic survey, the results of which portrayed the following: The patient was a pale, thin, anemic looking man, with haggard face, pigmented exposed areas, particularly the hands, where the lesions were bilateral and glove-like in distribution, with evident vesicles, bullæ, and old scars. The head was symmetrical; the pupils reacted to light and distance; the ears were normal; the turbinates were enlarged on the left side and the septum deviated to this side; tonsillar tags were present; the tongue was clean, smooth, and bright red, with areas of atrophic glossitis. The teeth were dirty, a mild grade of pyorrhea being present, and most of the molars were missing; the mucous membranes were pale. The thyroid was normal in size. The pulse rate was 72; the blood pressure, systolic 96, diastolic 66; pulse pressure 30; the heart normal in size by measurement and no bruits heard; the lungs normal; the abdomen greatly enlarged, about the appearance of a uterus at term; tympany was noted throughout. The

present; internal and external hemorrhoids were present; the prostate was normal.

A gastro-intestinal study revealed a normal esophagus and a stomach so greatly dilated as to fill the entire abdomen. The first part of the liquid barium entered the duodenum freely and then began to "back up." The first portion of the duodenum was dilated to thrice its normal size and reverse peristalsis was noted. By pressing the greater curvature of the stomach upward, and the first portion of the duodenum to the left, the second part of the duodenum was seen to narrow down to a diameter of what appeared to be from 2 to 3 mm., the barium slowly trickling through this into a normal third portion where it passed along at its usual rate. No masses or nodules were noted along this part. A very large residue was present after six hours (Fig. 1). The colon by enema was normal. The laboratory work showed a normal urine. The hemoglobin was 66 per cent (Dare); red blood cells, 3,220,000; white blood cells, 8,200; polymorphonuclear leukocytes, 67 per cent; small lymphocytes, 31 per cent, and large lymphocytes, 2 per cent; the blood Wassermann and Kahn tests were negative; blood chlorides were 450 mg. per 100 c.c. of blood.

A diagnosis of duodenal obstruction, etiology unknown, was made and operation advised.

On June 8, 1931, under spinal novocaine anesthesia, the abdomen was opened by Dr. A. W. Carley who found the stomach to be greatly distended. The gastro-colic ligament was divided to expose the third portion of the duodenum. Beginning about the second portion, the duodenum, which began to narrow to a point three-fourths inch below the diameter (Fig. 2), by vision and palpation, seemed to be about from 3 to 4 mm. in diameter, gradually enlarging in a conical manner for another three-quarters of an inch, when it again assumed its normal size. The appearance of the stenosis resembled a section of a glass tube drawn out to the 3 mm. diameter over a Bunsen burner. There was no internal or external cause apparent. The stenotic area was smooth, and a few fine lace-like adhesions were present over the narrowest portion. A posterior gastro-enterostomy was done and the abdomen closed. Five hundred c.c. of 5 per cent glucose in normal saline solution was given intravenously. The convalescence was uneventful and the patient returned to work eight weeks later. He had gained 30 pounds in weight, the eruption had cleaned up, and he could eat without distress.

COMMENT

The principal interest attached to this case lies in the combination of a gradually developing stenosis of the duodenum with evidence of a concomitant deficiency disease believed due to an inadequate diet engendered by the progressive stenosis. The lesions on the hands resembled pellagra, with the characteristic glove-like distribution of the dermatitis, the pigmentation, the vesicles, the bullae and the old scars, and general symptoms of atrophic glossitis and red tongue. Pellagra is thought to be due to a lack of Vitamin B, and in this instance the lack of fruits, vegetables, and other vitamin-bearing foods over a period of several years may have been the predisposing factor in its production. Snell and Bumpus (2) report a somewhat similar circumstance. Their case presented a deficiency syndrome with duodenal obstruction and ulcerative colitis, with an attempt at correction of the obstruction by a gastro-enterostomy. Death was sudden and apparently similar to deaths occurring in deficiency disorders. Kellogg's (1) recent excellent volume contains no reference to a similar condition.

CONCLUSION

1. Herein is reported a case of chronic duodenal stenosis in an adult, probably due to intrinsic inflammation of unknown etiology, and also its part in producing a pellagra-like

lesion as the result of a subsequent inadequate diet.

2. Cure of both lesions was affected by a gastro-enterostomy.

REFERENCES

- (1) KELLOGG, E. L.: *The Duodenum*. Paul B. Hoeber, 1933, page 367.
- (2) SNELL, A. M., and BUMPUS, L. D.: *Minn. Med.*, April, 1931, **44**, 336.

CHOLECYSTO-DUODENAL FISTULA WITH GALLSTONE OBSTRUCTION OF THE SMALL INTESTINE: A REPORT OF TWO CASES¹

By L. W. PAUL, M.D., *Madison, Wisconsin*

Assistant Professor of Radiology, University of Wisconsin Medical School

Occasional reports of cases of spontaneous fistula formation between the gall bladder and duodenum are to be found in the literature but the total number of such reported cases is still relatively small. The most recent one is that by Sickels and Hudson² in which they tabulate the cases reported, a total of 29, and add one of their own. In addition to these there were ten cases reported in which the filling of the bile ducts during a barium meal examination was stated to be due to reflux through the ampulla of Vater, but only five of these had surgical or postmortem verification.

Due to the apparent rarity of the condition and the unusual features in one of them, the following two cases are presented:

Case 1. The patient, a white female, 60 years of age, was admitted to the State of Wisconsin General Hospital on July 31, 1933, in a stuporous state, having been ill at home for the previous ten days. It was impossible to obtain an adequate history from the patient but the referring physician supplied enough information to justify the impression of bowel obstruction. There was nausea, vomiting, and abdominal distention. Under conservative treatment the patient improved, the distention subsided, and normal bowel movements occurred. However, the temperature continued to rise to 100° every afternoon. A roentgen examination by means of a barium meal was done on Aug. 8, 1933; it was reported

¹ From the Department of Radiology and Physical Therapy, University of Wisconsin; Chairman: Ernst A. Pohle, M.D., Ph.D., Professor of Radiology.

² SICKELS, T. N., and HUDSON, C. L.: Demonstration of a Spontaneous Biliary Fistula by Roentgen Examination. *Am. Jour. Roentgenol. and Rad. Ther.* January, 1934, **31**, 31-36.

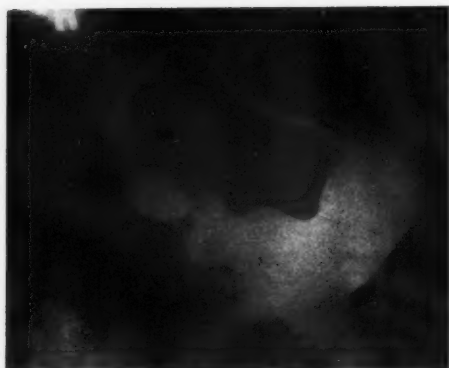


Fig. 1. Case 1. The common and hepatic ducts are filled with barium. Film taken shortly after the meal was given.

as follows: The patient was examined fluoroscopically in the recumbent position only. The heart appeared widened and the entire aortic arch was prominent. There was no delay in the passage of the meal through the esophagus nor at the cardia. The stomach filled out in a normal manner and showed normal peristalsis. The bulb filled spontaneously, was deformed, and there was an irregular tract filled with barium extending upward from the apex of the cap for a distance of several centimeters. The roentgenograms showed a stomach normal in size and with regular and even peristalsis. The bulb was grossly deformed and barium had escaped through a fistula into the common duct which was outlined almost throughout its entire extent. Both the right and left hepatic ducts were visualized as was the cystic duct, but none of the barium had entered the gall bladder. At six hours a small residue remained in the stomach. Many of the smaller bile ducts were filled with barium, as was the distal portion of the common duct. The head of the meal was in the lower ileum, with barium scattered throughout the small bowel, some loops of which were dilated. At 24 hours, several of the small bile ducts still contained barium. The balance of the meal was scattered throughout the colon which was in a contracted state.

Impression.—This examination demonstrates a fistulous connection between the duodenal bulb and the bile passages, probably the common duct. While it is possible for the fistula to be between the cap and gall bladder, the absence of gall-bladder filling makes this seem unlikely.

Upon further questioning, the patient stated that, while at the height of her illness, she had digitally removed a large stone from the rectum



Fig. 2. Case 2. Arrow points to common and hepatic ducts filled with air: air is visible in the gall bladder. Dilated gas-filled coils may be seen in the left upper quadrant.

before her admittance to the hospital. Operation was performed on Aug. 18, 1933, by Dr. J. W. Gale. The duodenum and pylorus were densely adherent in the region where the gall bladder should have been. After a long search the gall bladder was found. It was only one inch in length and no thicker than a lead pencil. A line of cleavage was found which opened into the duodenum just distal to the pylorus. The defect was between what remained of the gall bladder and the duodenum. The failure to fill the gall bladder clearly in this case was probably due to its small size and contracted state. The opening was closed and the gall bladder removed. Her convalescence was uneventful.

Case 2. The patient, a white male, 64 years of age, was admitted to the State of Wisconsin General Hospital on Feb. 1, 1934. He had had an appendectomy for acute appendicitis eight months previously, at which time several large stones were palpated in the gall bladder. Because of the toxic condition of the patient, cholecystectomy was not done. The present illness began several days before admission with cramp-like pains in the abdomen, and emesis. No bowel movements had occurred after the first day. The abdomen was distended and there was over-active peristalsis

in the left lower quadrant. A flat film of the abdomen taken in the upright position was reported as follows: There was a group of dilated coils of gas-filled small intestine in the left upper quadrant, with scattered areas of gas throughout the remainder of the abdomen. There was a Y-shaped collection of air extending upward and obliquely from the level of the second lumbar vertebra, with a rounded gas bubble adjacent. This was believed to represent air in the common and hepatic ducts and possibly in the gall bladder as well. These findings would indicate the presence of a cholecystoduodenal fistula, most likely the result of ulceration from a gallstone which had caused an obstruction in the jejunum.

Laparotomy was performed on Feb. 3, 1934, by Dr. J. W. Gale. There was found a U-loop in the ileum, due to adhesions. Proximal to this was a large gallstone the size of a hulled walnut. This was removed through an incision in the small bowel, it being impossible to force the stone into the cecum even after the adhesions were broken up. The patient's condition did not warrant further exploration or operative procedure. The post-operative course was satisfactory. Before discharge, a barium meal examination was done but none of the contrast substance could be seen entering the gall bladder.

This case illustrates the possibility of demonstrating fistulous connections between the gall bladder and duodenum by means of a flat-film examination and without the use of an opaque meal. It also confirms the value of flat-film examination in cases of acute bowel obstruction since in this instance an accurate diagnosis of the location and cause of the obstruction could be made before operation. Similar findings have been reported in only a few instances, and in one of the cases reported by Sickels and Hudson, air in the hepatic ducts was seen following a surgical anastomosis of the gall bladder and the duodenum.

In both of the cases reported in this paper there had been an ulceration of a large gallstone into the duodenum, with resulting small intestinal obstruction. In Case 1 the patient eventually passed the stone by rectum but the fistula persisted. In Case 2 the stone was stopped by a constriction in the bowel due to adhesions, necessitating operation for relief. Attempts at demonstration of the fistula after operation were unsuccessful and the patient was clinically well, indicating that healing may have occurred after the obstruction was relieved.

A SLIDE-RULE FOR CALCULATING RADIATION EXPOSURE WHEN CELLS OF UNIFORM RADIUM CONTENT ARE USED¹

By IRVING FRIEDMAN, M.D., *New Haven, Connecticut*

Following the suggestion of Dr. George T. Pack, the New Haven Hospital has recently adopted the method of keeping radium in small, uniform, platinum cells, each containing three and a third milligrams of element. In this form the radium may be used in a large variety of applicators; also, the calculation of dosage is thereby greatly facilitated.

A slide-rule has been devised which still further simplifies the calculation of exposure. Figures 1 and 2 illustrate the two faces of this instrument. On one side (Fig. 1) is a scale of logarithmic form, to compute the duration of exposure required in order to administer a desired amount of radiation with a given number of cells. On the other side (Fig. 2) is a scale of linear form, to determine the time of the day when the exposure should be terminated.

The operation of this device is best explained by the following illustrative example: Suppose that a dose of 3,600 milligram-hours of radiation is to be given in an applicator containing 16 cells, and that treatment is begun at 11 A.M.

The first sliding scale is adjusted so that the indicator points to 3,600 milligram-hours of radiation (Fig. 1). The required exposure is then read on the lowermost scale opposite 16, the number of cells, which would be in this case 67.5 hours.

The rule is then turned over, and the second sliding scale adjusted so that one of the two indicators points to 11 A.M. If the left-hand indicator were used (not illustrated), 67.5 hours would fall beyond the calibrated scale. In this instance, therefore, the right-hand indicator must be used, and it is then seen (Fig. 2) that the treatment should be terminated at 6:30 A.M. of the third day, the day being read on the same side as the indicator which marks the beginning of the exposure.

The slide-rule may be used with equal facility to calculate the amount of a given dose of radiation. Thus if the applicator in the above example were to be removed at 9 A.M. of the next day, this would complete 22 hours of exposure (Fig. 2). The first scale could then be set with 16 cells opposite the 22 hours (not illustrated), and the dosage read opposite the indicator, which would be in this case about 1,170 milligram-hours.

¹ Accepted for publication July 9, 1934.

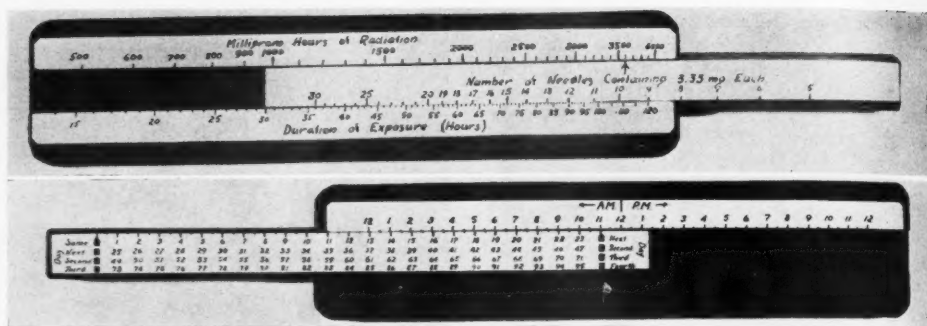


Fig. 1. (Upper).

Fig. 2. (Lower).

A properly made slide-rule of this type should be accurate to within a small fraction of 1 per cent. If uniform cells are used which have a radium content of other than 3.33 milligrams,

it is necessary to change the calibration of the first sliding scale in order to make the instrument applicable.

New Haven Hospital

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE ALL-ROUND-SQUARE MAN

Mark Twain's words come to me as an appropriate caption for what I have in mind.

Just what is our conception of a valuable life? Let us endeavor to draw some picture of what this title suggests. We see possibly the vision of a man great for his physical robustness, known for his breadth of vision, and respected for his uprightness of living. Somewhere between the pictures of the long-nosed pessimist and that of the overwhelming optimist, hangs the cameo we are seeking. The popular feminine conception lies perhaps out in Hollywood; and alas, the masculine idea, to judge from the papers, is secretly built up from the haunts of our underworld in the backstreets of Chicago, or in Edgar Wallace's productions.

But I do not propose to analyze the Clark Gables, however fetching their dimples; nor our Dillingers (a soft or a hard G, whichever you prefer). My attention wishes to draw yours in conceiving something of the essence essential to the fullness of life for the average professional man.

We, as professional men, are so habituated to speaking *ex cathedra* that we might well stop and ask ourselves just how far we are carrying this principle into every other department of our thought and action. Possibly we take for granted that we are well-rounded individuals. I find it a temptation to speak quite authoritatively on almost anything, since the public expects it, and it is hard to resist perpetuating such a myth. Of course it has long been an axiom among the racketeers that we professional men and women are the leading suckers and prize boobs for every imaginable speculation. Apparently it is our weakness, that, being trained in one field, we take for granted our knowledge in every other, and are quite unaware, and blissfully ignorant, that a scientific bent does not necessarily presage commercial talent, to their exceeding profit and our own certain distress and sorrow in the end.

But let us carry this further afield. Exactly what height and depth of view do we possess

outside of our own specialist's training? I am asking myself—am I allowing the absorbing professional existence of to-day to so narrow me down that I am out of touch and, therefore, largely out of sympathy with the major problems of "Everyman"? Where are the cultural and esthetic values which theoretically we acknowledge, but which have so little place in our own practical world?

Of course, you answer that we all join clubs to help meet this. But even with this advantage, it becomes very doubtful, since we are apt to merge our views with those of the group, and so confirm the obscurantism of our outlook.

Is it not rather pathetic to meet men distinguished in their particular fields, who yet might be living in Mars for all the contact they have with the life around them? One is tempted to suggest that their work suffers accordingly.

We all need an escape—some way to relieve the strain of the day and to give us time to regain some sense of the real values of life. After all, a man's work is done in a very narrow environment. His office and task chain him down, and it is with relief that he turns home at five o'clock (if he be fortunate), and allows his attention to rest by giving it a change. No doubt the modern detective story is the result of the times and the strenuous rushing life of the average man, who lives so strained an existence that he needs something more than even so pleasant a thing as chatting with his wife or cutting the lawn, to break the strain of the day. Some, of course, find relief in golf and bridge; others in politics and such-like sport; others have built up an "Ivory Tower" to which they may retreat from all the "slings and arrows of outrageous fortune." Whatever it is, it is essential to our well-being, and there is certain tragedy being stored up for the man who cannot "let go."

There is also, quite apart from the question of the modern pace which is undoubtedly shortening the lives of so many of us, a time in the life of "Everyman" when Nature says

"Slow up." The handwriting is on the wall, and woe betide that man who thinks he can ignore it. Is it not a false sense of pride which makes us afraid to face facts? Is our life so ill-arranged and ill-prepared that we fear to consider such a possibility and cannot face such a reality without a tremor? The Greeks of old knew better. There is surely a wrong perspective on life when we cannot meet the next inevitable step. Apparently the majority of us are so fixated by habit that we cannot be moved except by a miracle, and that usually comes too late and so finishes us. Surely the mature man can find a deeper satisfaction and a more useful sphere for himself by just stepping aside—be it ever so little—and leading a less engrossed life, less caught by the turmoil of ceaseless activity.

Watch the minds of those leading our armies in battle! Do they rush forward with sword in hand? That day is over for them. We find them standing back, and with their experience they are able to direct and suggest the most likely course of action. Their contribution is invaluable and necessary. All their training leads up to it, and in such values is success found. But in the ordinary life of the citizen we utterly ignore this fact. We senselessly imagine that because a man has left the front-line trench he is no longer of the faintest use—perhaps, because he leaves it too late. Actually he should be of greater use than ever before since he now has time for reflection. Our insane glorification of the active life has made us sacrifice some of the best values life has to offer, and made men afraid to face what is so inevitable. The disastrous results of attempting to hold on are pathetic to see. Man's "will-to-power" ends by making him a slave, riding him, tyrannizing over him and all who come within its reach. The indispensable elements of life for the individual are surely deeper than this. The crystallization of a man's contribution probably never ripens till after he has ceased the violent urges of his existence, and had time to reflect and weigh. We may well pity the man who never reaches that stage. He is like fruit that never fully matures.

However, it is only in passing that I stop to consider this angle of the "all-round-square" man. I want particularly to approach him in the light of the average professional. Just what does he see in life outside of his work? Do we not live for the most part sublimely

unconscious of the great world about us? In one sense this is our forte and safeguard; on the other hand it is our weakness, affecting our work and leading many of us to question the richness of our existence. It is not that we want to make of our days a sixteen- or thirty-two page "yellow" journal. Heaven forbid! But there is an unnecessary meagerness about our lives, stifling and dulling in its effects. No doubt you feel as I do, that, having one life to live, it should be lived fully, richly, and completely; not in abnegation but in constructive realization should we fulfill ourselves. We all seek a richly rounded existence which, rising to a final curtain, shall have fully completed itself. But deeply satisfying as our work may be, there come to many of us moments of doubt and a sense of futility, which, it seems to me, are largely in our own hands to remedy.

I think of man in terms of his reserve forces; just what he builds up to keep his outlook well balanced, so that it may properly mature; what he has as reserves for the day when just mere activity passes from him. The best authorities are unanimous in agreeing that the man cannot give of his best who limits himself just to his work. Broader horizons are necessary if he would see straight. The complaint of poverty of life can be overcome in the riches of values other than our own. We hear a great deal about "national preparedness" these days, but what of individual preparedness? We need to build up reserves of the spirit, the content of which is the essence of our real and ultimate value to the world, and which must be guarded with a two-edged sword. If we disregard this and dissipate life in just quantitative things, we shall find the accumulation of our days dispirited indeed.

Can we escape the insidious fixation of the routine of clinical life which threatens to so circumscribe our outlook that we fail or lack time to see the finer and deeper gifts awaiting us? I think we can. But it is only by guarding the treasure of life, constantly keeping open the broader and deeper avenues of thought, that we can enter into the life of the community with a better estimate of the necessities of other men's lives.

Then in the glow of the setting sun we shall find life triumphant; no longer shall we be desperately clinging in frantic competition to keep up with the coming tide of youth, but able to offer a quiet and finer contribution from a mind at peace with itself, well-balanced,

and having a breadth of vision denied to those just leaping into the game. In a word, an "all-round-square" man.

W. HERBERT MCGUFFIN, M.D.

COMMUNICATIONS

THE FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

ZURICH—ST. MORITZ, SWITZERLAND,
JULY 24-31, 1934

The Fourth International Congress when viewed in the light of present-day economic stress and international unrest must be rightfully permitted to take place and rank with the three previous admittedly successful congresses. Great credit for this happy conclusion is willingly granted the able and energetic President, Dr. Hans R. Schinz, and his equally efficient and courteous Secretary-General, Dr. Hans E. Walther. It is impractical to name all of the officers and local committeemen who served faithfully and well but outstanding among them are Vice-president, Dr. René Gilbert, and Assistant Secretary Dr. Stewart-Harrison.

Scientific Program.—This on the whole was excellent and not overbalanced by social functions as has occurred on former occasions. Some criticism, however, has been directed against the over-abundance of material, which resulted in limiting the essayists, with a few exceptions, to ten minutes each. Over two hundred articles were read; they will be published in book form and sent to all members later.

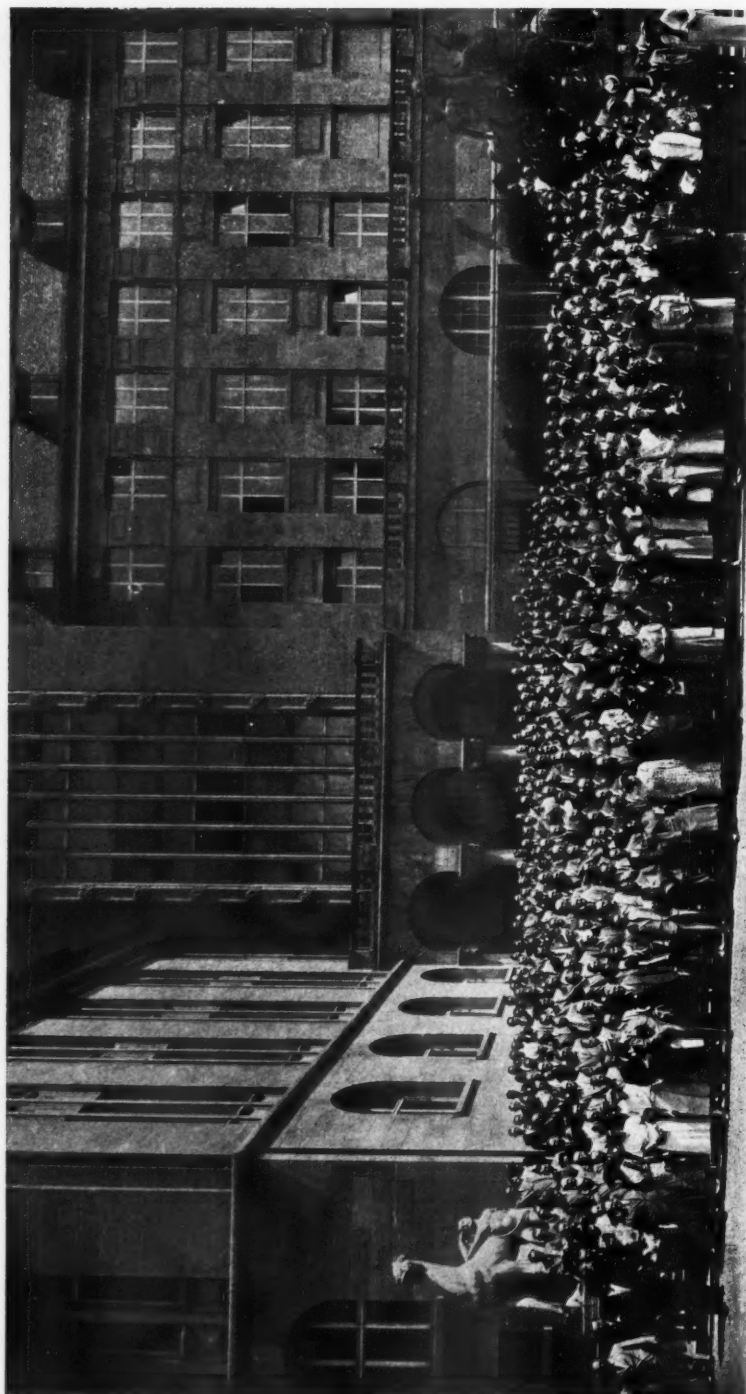
Scientific Exhibits.—These were representative and quite up to our own American standards. One unusual feature was a demonstration of the use of diagnostic roentgenology in the detection of flaws in a great many opaque materials. Also the detection of altered penmanship in forged papers or documents and in fraudulent paintings, etc.

Commercial Exhibits.—Here was a revelation—or, one might say, a revolution—in the character of apparatus since the first Congress in London just nine years ago. The sturdy construction, the excellent workmanship and pleasing appearance of nearly all x-ray apparatus and accessories assembled were arresting. The radiologist looks upon this scene with both admiration and alarm, for is it

not necessary for him now to discard certain equipment purchased two or three years ago? And how is he to set aside from his meager income sufficient funds to obtain this ultra-modern apparatus so necessary if he is to maintain equality with his more fortunate brother radiologists in this sharply competitive electrical era? Would that the non-radiological practitioner of medicine and surgery, and the average patient could be made to appreciate this situation!

The Opening Session.—The ceremonial opening session with over 1,200 delegates from 43 countries present will be long remembered. The Stadtteater at Zurich was beautifully decorated with flowers and festoons and the seats were all occupied—perhaps 2,000 in all and 13 speakers on the stage. President Schinz of the Congress opened the meeting, with a response from Dr. Bécélère. Bundesrat Dr. Etter addressed the meeting on behalf of the government. Responses were made by Dr. C. Thurstan Holland, Prof. Maier, and Prof. Niggli. Prof. Forssell, representing Sweden, then opened the International Cancer Conference, to which 27 nations had contributed. The following were invited to respond in order named: Dr. Soiland, for U. S. A.; Dr. Ledoux-Lebard, for France; Prof. Palmieri, for Italy; Prof. Maisin, for Belgium. This was followed by Prof. Sauerbruch, of Germany, who spoke on the surgical side of cancer treatment, to which Prof. Frick, of Germany, responded on the radiological side of the question. The session closed with an orchestral rendition of the national hymn. That evening an unusual Swiss festival was staged for the benefit of the members at the Dolder Grand Hotel and environs. It is called Mistura Helvetia and consists of groups of men and women from the different Swiss districts, in their colorful costumes of every design; singing, dancing, and yodeling to the harvest moon. There were some fine songs, good symbolic dancing, and some ritualistic performances with grotesque and hideous masks. Huge bonfires on the slopes below the hotel terminated the fête.

Business Session.—Before the International Executive Committee, the official delegates from the United States invited the next congress to America in 1937. Italy and Germany also presented invitations. After some discussion the latter countries graciously withdrew and the United States received the unanimous



Fourth International Congress of Radiology, Zurich-St. Moritz, July 24-31, 1934.

vote of the delegates assembled. The basic law of the International Congress of Radiology provides that the country selected for the meeting shall, through its official delegation, elect the president of the congress and name the time and place of the meeting. Our delegation consisted of Dr. B. H. Orndoff, Radiological Society of North America, President; Dr. Lawrence Reynolds, American Roentgen Ray Society, Vice-president; Dr. Albert Soiland, American Medical Association, Section on Radiology, Secretary; Dr. G. Failla, American Radium Society; Dr. Byron H. Jackson, American College of Radiology, absent. Dr. W. W. Wasson, alternate to Dr. Jackson, was also absent. The four delegates present discussed earnestly the problems connected with their new responsibilities. It was finally unanimously decided that Dr. Arthur C. Christie, of Washington, D. C., was well qualified to carry the honor and responsibility of conducting the Fifth International Congress of Radiology to a successful conclusion. The question of a meeting place was most seriously discussed, with New York, Washington, and Chicago strong favorites. After considerable debate it developed that Chicago had facilities for housing the whole Congress under one roof including members, exhibits, committee rooms, meeting rooms, etc. Dr. Benjamin H. Orndoff was elected Secretary-General by unanimous action and as President of our delegation presented our decision to the body assembled. Our delegation had suggested June as a tentative time but it developed that the great majority present preferred September. President Schinz then announced the result: Fifth Congress, U. S. A.; Dr. A. C. Christie, President; Dr. B. H. Orndoff, Secretary-General; place, Chicago, Illinois; time, early in September, 1937. Action warmly applauded by all delegates seated.

Sessions.—The scientific sessions occupied four days of the total seven in Zurich and were operated in four sections, the meeting places being the University Building and the Technical High School. The arrangements for lanterns, illumination, and general facilities were adequate.

St. Moritz.—Special trains were provided on the narrow gauge railroad for St. Moritz, and the climb up to the tiny azure blue lake completely surrounded by ice-capped mountain peaks is beyond description. Our hotel, the Palace, was situated on the border of this

placid lake which was fringed by beautiful green foliage, shrubbery, and stately pines, the latter ascending the mountain slopes. Sunday was a day of rest and relaxation except for those members who ventured up into the snowy heights.

The American College of Radiology.—The Fourth International Conference was held at the Hotel Kulm, where Executive Secretary Orndoff had arranged for our sessions. A brief reception was held before the dinner to which English-speaking Congress members had been invited. This proved a pleasing innovation. After dinner Secretary Orndoff introduced the Presiding Officer, who, in the name of President Groover (unfortunately prevented from attending the Congress), conferred the degree of Honorary Fellowship upon Prof. Aristide Busi, the Dean of Italy's radiologists. Fellow Busi responded in the Italian language which was ably translated into English by Fellow Tandoja. The topic of the Conference was then called for, namely, recent trends and present status of the practice of medical radiology. Honorary Fellow C. Thurstan Holland responded for the British Isles, Honorary Fellow Gosta Forssell for Scandinavia and Northern Europe, Honorary Fellow Hans Schinz for Switzerland and Central Europe, Honorary Fellow Pasquale Tandoja for Italy and Southern Europe, and Fellow George E. Pfahler for the United States. Dr. Pfahler spoke feelingly upon the splendid spirit of comradeship which had accrued to the Fellows of the College through these international conferences. He prophesied a truly harmonious and profitable future for our College. Honorary Fellow Antoine Bêclère responded in like vein, and at the conclusion of the session your scribe heard a great many complimentary remarks, directed principally toward our efficient and tireless Executive Secretary for his altruistic work for the College. The roll call demonstrated the presence of 17 Honorary Fellows, 19 regular Fellows, and 14 guests, a total of 50.

The Congress.—The following day scientific sessions were resumed, which came to a close Tuesday evening with, first, a closing ceremonial at the Stadium and, later, a subscription banquet (20 Swiss francs per plate). One noted quite acutely the thin American dollar which melted so rapidly in Switzerland. Wednesday and Thursday were devoted to sight-seeing tours and friendly visits. All the dele-

gates with whom your scribe could converse in ordinary English, fair Scandinavian, worse German, and impossible French and Spanish promised their whole-hearted support to the Fifth International Congress of Radiology in Chicago, Illinois, U. S. A., during the first two weeks of September, 1937. The log of Secretary-General Walther when last inspected had listed 1,234 foreign members and 50 Americans, a total of 1,284.

ALBERT SOILAND, M.D.

NOTES CONCERNING THE INTERNATIONAL CONGRESS AT ZURICH

As one examines the program of the Fourth International Congress which closed the last of July in Zurich, Switzerland, one cannot but be impressed with the names of the leaders in the science which appear therein. The general information section of the program is printed in French, German, and English. American readers are particularly interested in the papers by English-speaking members of the Congress. The following are among those so listed:

- Radiotherapy of Cancers of the Buccal Cavity and Pharynx, by N. S. Finzi, of London.
- The Treatment of Cancer of the Mouth by Surface and Interstitial Irradiation, by George E. Pfahler, M.D., of Philadelphia.
- Radiation Genetics, by H. J. Muller, Ph.D., of Austin, Texas.
- The Suitability of the Roentgen as a Unit of Gamma-ray Quantity or Dose, by G. W. C. Kaye, of London.
- Wilhelm Conrad Röntgen, by Otto Glasser, Ph.D., of Cleveland, Ohio.
- Safety in Screen Examinations, by A. E. Barclay, of Cambridge, England.
- Schüller's Disease, a Reticulo-endotheliosis, by Woodburn Morison, of London.
- Sinus Diagnosis, by Edwin C. Ernst, M.D., of St. Louis, Mo.
- The Roentgen Study of Detachment of Semilunar Cartilages, by W. Edward Chamberlain, M.D., of Philadelphia.
- Kymophonoradiography, by I. Seth Hirsch, M.D., of New York City.
- Anomalies of the Colon: Their Roentgen Diagnosis and Clinical Significance: Résumé of Ten Years' Study, by John L. Kantor, M.D., of New York City.
- Errors in Cholecystography and How to Avoid Them, by James T. Case, M.D., of Chicago.
- Sources of Error in Oral Cholecystography, by

- William H. Stewart, M.D., and H. Earl Illick, M.D., of New York City.
- Some of the Difficulties in the Interpretation of Cholecystograms, by Cassie B. Rose, M.D., of Chicago.
- The Mesentery: A Radiologic Study, by Raphael Pomeranz, M.D., of Newark, New Jersey.
- High Voltage X-radiation of Syringomyelia, by Frederick W. O'Brien, M.D., of Boston.
- A Recent Addition to the Organizations in Great Britain for Treating Cancer, by J. C. McLennan, of London.
- Principles in the Construction of Cancer Statistics Showing the Result of Treatment, by Arthur B. Smallmann, of London.
- Study of Cancer in Egypt from the Statistical, Social, and Radiotherapeutic Points of View, by Mahmoud Afifi, of Alexandria, Egypt.
- Changes in the Lungs and Pleura Following Roentgen Treatment of Cancer of the Breast by Intensive Fractional Method, by Harriet McIntosh, M.D., of New York City.
- Further Experience in the Value of Pre-operative Irradiation with the X-ray or Radium, and Pre- and Post-biopsy Irradiation while Submitting the Pathological Sections to a Number of Experienced Pathologists, by Joseph C. Bloodgood, M.D., of Baltimore.
- Three and One-half Years of Experience with 600 to 900 K.V. (Peak) of Prostatic and Rectal Malignancy, by Seeley G. Mudd, M.D., and C. K. Emery, M.D., of Pasadena, California.
- Conservative Methods in the Treatment of Cervical Lymphatics in Intra-oral Carcinoma, by James J. Duffy, M.D., of New York City.
- Present Methods of Treating Neck Metastases at the State Institute for the Study of Malignant Diseases, by Burton T. Simpson, M.D., of Buffalo, New York.
- A Modified Coutard Method for Treatment of Cancer of the Upper Air Passages, by Maurice Lenz, M.D., of New York City.
- Protracted External Irradiation in the Treatment of Neoplasms of the Upper Respiratory Tract: A Comparison of X-rays, Five-gram Radium Pack, and One Hundred-milligram Radium Pack, by Milton Friedman, M.D., and Rieva Rosh, M.D., of New York City.
- The Treatment of Cancer of the Pharynx, Tonsil, Antrum, and Extrinsic Larynx by Divided Doses of External Irradiation, by

ANNOUNCEMENT

NEXT ANNUAL MEETING

Memphis, Monday, Dec. 3—Friday, Dec. 7

PRELIMINARY REPORT OF SPORTS COMMITTEE

Memphis, down in Dixie—the city where play is business and business is pastime. Just twelve miles to Mississippi, where the magnolias pour forth their fragrant odor all spring and summer and where the wild ducks and geese play all winter. Over the river is Arkansas, where the cotton grows, the negro huns, and the corn boils.

There are nine golf courses at one's service; three country clubs, three municipal and three semi-private courses—all bid you a hearty welcome. Bring along your trusty niblick. The weather is usually fine for outdoor sports in early December.

Tennis a-plenty—Memphis and Chickasaw Country clubs and the University Club have excellent courts. If you do not like our racket, bring your own.

There are quail on the hillsides, ducks in the marshes and rice fields, geese on the sand-bars, and turkey and deer in the densely wooded areas. If you get pleasure from the wilds, bring along your old reliable double barrel and a pair of boots (the diamond backs and copper heads may not all be sleeping for winter).

North a short drive is our famous Reel Foot Lake; south are Moon and Horn lakes, and southwest is Horseshoe Lake. More fish of all varieties can be caught than one needs in one day. Don't forget your rod.

The Mississippi affords a wonderful place for boating, provided the waves are not too high.

Horseback riding astride Tennessee thoroughbreds is a real sport and all you need is a cushion for the next day.

Should the weather prevent the outdoor sports, there is a plenty of handball and bowling for recreation and exercise.

All of the above sports are available and you are welcome. Should you desire a hunting or fishing trip, write to the Committee in advance so that arrangements may be made for you.

W. R. BETHEA, M.D., *Chairman*

W. A. RUNKLE, M.D.

W. D. ANDERSON, M.D.

Hayes E. Martin, M.D., of New York City. Treatment of Teratoma Testis by Roentgen Rays, by R. S. Ferguson, M.D., and Harry Hauser, M.D., of New York City.

The Treatment of Mammary Carcinoma with Roentgen Rays, Using Small Daily Doses through Several Ports, by Frank E. Adair, M.D., of New York City.

High Voltage Cathode Rays, by T. E. Allibone, of Manchester, England.

The Comparative Effect of Very Hard X-rays and Gamma Rays, by Daniel Den Hoed, of Amsterdam, Holland.

Irradiation of Chick Tissues *in Vitro* and *in Ovo*, by C. W. Wilson, F. G. Spear, A. F. W. Hughes, and A. Glucksmann, of Cambridge, England.

The Reactions of Normal and Pathological Tissues to Teleradium Therapy, by Max Cutler, M.D., of Chicago.

The Distinction between X-rays of Different Origin, by Lauriston S. Taylor, of Washington, D. C.

Back-scattering as a Function of Quality of Radiation, by Edith H. Quimby, C. F. De Lucas, and A. N. Arneson, of New York City.

The Luminescent Properties of Zinc Sulphide in Relation to X-rays, by Leonard Levy and Donald West, of London, England.

The Small Ionization Chamber, by Otto Glasser, Ph.D., and U. V. Portmann, M.D., of Cleveland, Ohio.

Comparison between Teleradium and Deep X-rays, by W. V. Mayneord, of London.

Measurements of High Voltage X-rays and Gamma Rays in Roentgens, by W. V. Mayneord and J. E. Roberts, of London.

A Spectrographic Method of Measuring Voltage Wave Form of a Roentgen Tube, by R. R. Newell, M.D., of San Francisco, California.

X-ray Cinematography, by Russel J. Reynolds, of London.

Radiotherapy at 700 K.V., by G. Failla, D.Sc., of New York City.

The Therapeutic and Economic Phases of Higher Voltage X-rays, by Albert Soiland, M.D., of Los Angeles, California.

At the next International Congress, the Fifth, to be held in Chicago, in 1937, there will doubtless be a preponderating share of papers in the English language, the great value of which to North American radiologists can be foreseen. Though the number this year was not great, its value is beyond measure.

BOOK REVIEWS

THE BIOLOGIC EFFECTS OF RADIATION.

GAETANO VIALE, Professor of Physiology at the Royal University of Geneva. A volume of 368 pages, with 50 illustrations and 2 colored tables. Published by Fratelli Treves, Milan, Italy, 1934. Price, cloth, 10 lire.

This is another of the "Monographs and Treatises of Biology and Medicine" series, edited by Prof. Carlo Foa, and is more or less a complementary volume to Perussia and Pugno Vanoni's book, "Treatise of Roentgen and Radium Therapy," for in it Viale takes up all the electromagnetic radiations which are the basis for photo- and actinotherapy. Radiologists, biologists, and physiologists will find in this book an excellent presentation of the radiations in Nature (pp. 1-10), the solar spectrum and the biologic effects of sunlight (pp. 11-43), the principles of photochemistry (pp. 46-63), the effects of light on the organism as a whole (pp. 64-98), on micro-organisms, plants, and the lower animals (pp. 99-128), and then their action on man and the higher animals (pp. 129-213), the action of infra-red rays (pp. 214-218), polarized light (pp. 219-221), the mitogenetic radiations (pp. 222-242), bio-radio-activity (pp. 243-266), cosmic rays (pp. 267-271), photodynamic phenomena (pp. 272-300), pigmentation (pp. 301-318), diseases due to light (pp. 319-328), the principles of phototherapy (pp. 329-344), and finally the mechanism of the action of light (pp. 345-348), a truly complete presentation.

RADIOLOGY OF THE GALL-BLADDER: AN ANATOMIC, FUNCTIONAL, AND CLINICAL STUDY.

By NEMOURS-AUGUSTE, radiologist of the Paul Brousse Hospital. Preface by Professor Roussey. A volume of 186 pages with 102 illustrations and 27 *planches hors texte*. Published by Masson et Cie, Paris, 1934. Price, 45 francs.

The last ten years have witnessed the ripening of a most remarkable advance in the diag-

nostics of internal medicine. The perfection of cholecystography by Graham has opened up a wide field of investigation of gall-bladder disease and many of its complications. Also, monographs on the subject have appeared, not only in English but in other languages, including French, German, and Spanish. This new work by Nemours-Auguste is a very complete treatise on the radiologic investigation of the gall-bladder, both with and without the aid of cholecystography. The relation of the gall-bladder to the duodenum and the hepatic flexure is included in the discussion. The book contains chapters on the following subjects: extrahepatic biliary passage; the known functions of the gall-bladder in relation to the roentgenologic examination; the preparation of the patient and the technic of the injection or oral administration; the roentgenographic technic; a complete discussion of the normal gall-bladder, and of chronic gall-bladder disease, including cholelithiasis, pericholecystitis, and cancer of the gall-bladder. A chapter is devoted to the indirect roentgenologic signs of cholecystitis. The final chapter deals with the alleged lack of agreement between the clinical and the radiologic findings. Clinicians are sometimes astonished to find that a diseased gall-bladder, with or without stones, can be filled by the "tetraiod," and become visible to the x-rays, and to find the same appearance in a gall-bladder which would be called by them "normal" on a single film.

After considerable discussion, the author concludes that the discord is more apparent than real and arises from incomplete or faulty interpretation of the cholecystograms. It should be recognized that a good roentgen diagnosis depends on perfection of technic and the recognition of the recent researches in the physiology of the biliary passage. Failure in either regard may result in error. There is nothing outstandingly new in this volume, but it may be said of it that it constitutes an excellent presentation of the subject.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

The Appendix.....	377	The Lungs.....	384
Arthritis.....	377	Mucous Colitis.....	384
Biologic Effects.....	377	The Pelvis.....	385
Blood Changes.....	377	Peptic Ulcer.....	385
Bone Diseases (Diagnosis).....	378	Radium.....	385
Calculi.....	379	Sacro-iliac Joint.....	385
Chest Roentgenography.....	380	Schüller-Christian Syndrome.....	386
Contrast Media.....	380	Silicosis.....	386
The Esophagus (Diagnosis).....	380	The Stomach.....	386
Gastro-intestinal Tract (Diagnosis).....	381	The Trachea.....	387
Heart and Vascular System.....	381	Tuberculosis, Pulmonary.....	387
Hyperparathyroidism.....	383	Tuberculosis, Renal.....	387
The Knee Joint.....	383	Tumors (Diagnosis).....	388
The Larynx.....	384	Tumors (Therapy).....	388
The Liver.....	384	Ultra-violet Light.....	390

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J. E. HABBE, M.D., of Milwaukee, Wis.
HANS W. HEFKE, M.D., of Milwaukee, Wis.
HANS A. JARRE, M.D., of Detroit, Mich.

DAVIS H. PARDOLL, M.D., of Chicago
ERNST A. POHLE, M.D., Ph.D., of Madison, Wis.
CHARLES G. SUTHERLAND, M.D., of Rochester, Minn.

CONTENTS OF ABSTRACTS IN THIS ISSUE, LISTED ALPHABETICALLY BY AUTHORS

V. ALPOELDY, ZOLTAN. Chronic Disturbances of Motility in the Duodenum.....	381	GUTMAN, ALEXANDER B., SWENSON, PAUL C., and PARSONS, W. BARCLAY. The Differential Diagnosis of Hyperparathyroidism.....	383
BAENSCH, W. Radium Therapy of Hemangioma.....	385	HAAS, M., and LOB. The So-called Specific Effects of Short Electric Waves in the Treatment of Malignant Disease.....	390
BALLIN, MAX. Parathyroidism—Its Clinical Symptomatology.....	379	HALL, E. WALTER. Ankylosing Spondylitis and Polyarthritides (Bechterew, Strümpell-Marie, and Related Types).....	378
BARNES, JOHN M., and STEDEM, DANIEL E. Multiple Aneurysms of the Smaller Branches of the Pulmonary Artery.....	382	HAMPTON, AUBREY O. The Incidence of Malignancy in Chronic Pre-pyloric Gastric Ulcerations.....	381
BEUTEL, A. Papillomatosis of the Trachea and Main Bronchi.....	387	HASCHÉ, E., and LEUNG, H. The Problem of Dosage in Ultra-short Wave Therapy.....	377
BUETZLER, O. The Differential Diagnosis of Phleboliths and Ureteral Calculi in Roentgenograms of the Small Pelvis.....	385	HAYER, E. Results of Experimental Studies in the Peripheral White Blood Picture Following Roentgen Irradiation.....	377
CLERF, LOUIS H., and MANGES, WILLIS F. The Congenitally Short Esophagus.....	380	HEDFELD, A. Malignant Tumors and Their Treatment by Irradiation.....	388
CURRIER, FRED. P., with DAVIS, DAVID B.....	378	HODGES, PAUL C., and LEDOUX, ALFRED C. Osteomalacia: A Brief Review of the Modern Conception of the Disease.....	379
DAVIS, DAVID, B., and CURRIER, FRED. P. Morquio's Disease: Report of Two Cases.....	378	IRWIN, R. L., with KEEFER, C. S.....	383
DIETEL, F. G. What Are the Accomplishments of Radiation Therapy in Inoperable Carcinoma of the Cervix?.....	389	JACOX, HAROLD W. Superior Pulmonary Sulcus Tumor: Further Observations, with Report of Two Additional Cases.....	389
DOUGLAS, B. H. The Importance of the Roentgen Examination in the Modern Treatment of Pulmonary Tuberculosis.....	387	JAMIYA, CHICHIO, and NOSAKI, SCHUEI. Diagnosis and Therapy of Pedunculated Esophageal Tumors.....	381
DU MESNIL DE ROCHEMONT, RENÉ. Roentgen Therapy of Mediastinal and Lung Tumors.....	389	KADRINKA, S. The Value of the Contrast Enema for the Demonstration of the Appendix.....	377
DYES, OTTO. A Contribution to Brain Arteriography.....	380	KALLÓS, PAUL, and KALLOS-DEFFNER, LISELOTTE. The Effect of Ultra-violet Rays on the Carbohydrate Metabolism.....	390
EISENDRATH, DANIEL N. The Diagnosis of Renal Tuberculosis by Cultures Made from the Urinary Sediment.....	387	KALLÓS-DEFFNER, LISELOTTE, with KALLÓS, PAUL.....	390
FARRELL, JOHN T., JR., with MANGES, WILLIS F. Further Roentgen-ray Studies of Carcinoma of the Stomach.....	386	KEEFER, C. S., PARKER, F., JR., MYERS, W. K., and IRWIN, R. L. Relationship between Anatomic Changes in Knee Joint with Advancing Age and Degenerative Arthritis.....	383
FELDMAN, MAURICE. Further Roentgen-ray Studies of Carcinoma of the Stomach.....	386	KNOFLACH, JOSEF G., with FREUND, LEOPOLD.....	389
FELDMAN, W. H., with LEMON, W. S.....	386	KRUGLIKOWA, R. K. Roentgen Therapy of Scleroma of the Upper Air Passages.....	390
FICHERA. The Biologic Treatment of Carcinoma and its Relation to Radiation Therapy of Neoplasm.....	389	LEDoux, ALFRED C., with HODGES, PAUL C.....	379
FREUND, LEOPOLD, and KNOFLACH, JOSEF G. Telangiectasis and Radiation Therapy.....	389		
FRICK, K., and OTT, P. Roentgenologically Circumscribed Tumors of the Alimentary Canal and the Difficulties of Their Differential Diagnostic Interpretation.....	388		
GREELEY, PAUL W. Sialolithiasis.....	379		

LEMON, W. S., and FELDMAN, W. H. Comparison of the Development of the Specific Nodule of Silicosis and of Tuberculosis....	386	SCHINZ, H. R., and ZUPPINGER, A. Report Regarding the Experience in Zürich with Protracted Fractional Roentgen Therapy from 1929 to 1932 in Tumors of the Upper Air Passages and Digestive Tract.....	388
LEUNIG, H., with HASCHÉ, E.....	377	SOSMAN, MERRILL C., and WOSIKA, PAUL H. Calcification in Aortic and Mitral Valves, with a Report of 23 Cases Demonstrated <i>in vivo</i> by the Roentgen Ray.....	382
LOB, with HAAS, M.....	390	STAUNIG, K. Peri-arthritis Humero-radialis....	377
London letter, <i>Jour. Am. Med. Assn.</i> So-called Mucous Colitis.....	384	STEDEN, DANIEL E., with BARNES, JOHN M.....	382
McGEHEE, W. H. Importance of the Roentgen Examination in Polypoid Tumors of the Larynx.....	384	STEFFENS, WALTER. Iodipin-embolism of the Liver.....	384
MANGES, WILLIS F., with CLERF, LOUIS H.....	380	STEWART-HARRISON, R. The Roentgen Therapy of Schüller-Christian's Disease.....	386
MANGES, WILLIS F., and FARRELL, JOHN T., JR. Significance of Roentgenologic Changes in Differential Diagnosis of Atelectasis.....	384	STRAUSS, MAURICE B. The Rôle of the Gastro-intestinal Tract in Conditioning Deficiency Disease: The Significance of Digestion and Absorption in Pernicious Anemia, Pellagra, and "Alcoholic" and Other Forms of Polyneuritis.....	381
MYERS, W. K., with KEEPER, C. S.....	383	STUMPF, P. Kymographic Analysis of the Movements of the Heart.....	381
NOSAKI, SCHUEI, with JAMIYA, CHICHIO.....	381	SWENSON, PAUL C., with Gutman, Alexander B..	383
OTT, P., with FRICK, K.....	388	WILCOX, LESLIE F. Osteopoikilosis.....	378
PARKER, F., JR., with KEEFER, C. S.....	383	WOSIKA, PAUL H., with SOSMAN, MERRILL C.....	382
PARSONS, W. BARCLAY, with GUTMAN, ALEXANDER, B.....	383	ZUPPINGER, A., with SCHINZ, H. R.....	388
PESEK, GOTTFRIED. The Diagnosis of Peptic Ulcer of the Esophagus.....	385		
PHILIPP, E. Typical Birth Trauma of the Sacro-iliac Joint.....	385		
PINNER, MAX. Roentgenological Manifestations of Allergic Processes in Pulmonary Tuberculosis.....	387		
PIRIE, A. HOWARD. Marble Bones.....	378		
RICHARDS, G. E. The Interpretation of the Triangular Basal Shadows in Roentgenograms of the Chest.....	380		

Abstracts of Current Literature

THE APPENDIX

The Value of the Contrast Enema for the Demonstration of the Appendix. S. Kadrnka. *Röntgenpraxis*, February, 1934, 6, 73-84.

Appendices to the number of 400 were roentgenologically examined by the barium enema method. The observation of Berg and Knothe, that the filling of the appendix takes place only after the patient has expelled the enema, is confirmed. The appendix is filled by the enema method as often as by any of the modified oral methods. The advantage of the former lies in the saving of time and films; and the entire colon may be adequately examined, which is not possible with any of the oral methods. A disadvantage is the non-filling of the appendix in obstinate atony of the cecum, and in coprostasis. In these cases filling of the appendix by the oral administration of a barium-epsom salt mixture seems to give better results. The non-filling of the appendix, provided the correct technic has been used, is the most important roentgenologic symptom of a pathologic appendix and is correct in 90.7 per cent of the cases (checked by surgery). The non-filling appendix might be compared with the non-functioning gall bladder. The enema method has taken the place of the oral method in the author's clinic.

HANS W. HEFKE, M.D.

ARTHRITIS

Peri-arthritis Humero-radialis. K. Staunig. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, 49, 90-92.

Several patients presented themselves with complaints of pain in the elbow which occurred suddenly on lifting, limitation of motion, slight swelling over the lateral parts of the joint, localized and intense pain on pressure over the radial capitellum. One case is reported with very severe symptoms of this type, but, while all previous cases showed no roentgenologic pathology, incrustations were demonstrated in this last case in the humero-radial joint capsule. An unusually marked degree of peri-arthritis "humero-radialis" is assumed, similar to peri-arthritis humero-scapularis.

The opinion is expressed that these manifestations belong to arthritic diathesis and that mechanical and static conditions at various joints are responsible for varying demonstrable "arthritic" changes—erosions and destructions of articular surfaces, when pressure is to be borne, capsular changes, when tension is applied.

H. A. JARRE, M.D.

BIOLOGIC EFFECTS

The Problem of Dosage in Ultra-short Wave Therapy. E. Hasché and H. Leunig. *Strahlentherapie*, 1934, 50, 351-356.

The authors studied the effect of short electric waves (8-16 meters) on staphylococci kept in distilled water, physiological NaCl₂ solution, in broth, and on streptococci in milk. Their experiments did not show any definite effects of the electric waves on the biological material. They emphasize, however, that in spite of these negative experiments *in vitro* there is no doubt as to the remarkable clinical results produced by these waves in inflammatory processes.

ERNST A. POHLE, M.D., Ph.D.

BLOOD CHANGES

Results of Experimental Studies in the Peripheral White Blood Picture Following Roentgen Irradiation. E. Hayer. *Strahlentherapie*, 1934, 50, 193-236.

The author studied changes in the white blood picture in the peripheral blood of dogs following exposure to roentgen rays. Heavily filtered radiation was used: 180 K.V., 0.5 mm. Cu, H.V.L. in Cu, 0.9 mm., field sizes 8 × 10 and 10 × 15, F.S.D. 75 cm., varying doses from 300 to 600 r. Very detailed studies of the differential count were made, the blood oxidase was followed over a period of several weeks, and a functional test was also used. The latter consisted of the injection of turpentine in order to produce a sterile abscess, followed by a study of the leukocyte picture. If a small volume of tissue in the upper thigh was irradiated, the lymphocytes dropped first, followed by an increase of short duration. If an abscess was produced after the exposure, it took the same course as in untreated controls. Following exposure of the spleen there was a definite decrease in all leukocytes lasting for several weeks. The characteristic changes in the white blood picture after producing an artificial abscess were the same as in the other dogs. The formation of the abscess was sometimes slightly delayed. In general, it appears that, following local exposure, the changes in the white blood picture depend largely on the irradiated tissue volume. If the entire body of the animal is irradiated, there is a marked drop in all leukocytes lasting for weeks; all types of leukocytes participate in this reaction. The injuries to the organism are so pronounced that the usual reactions observed in the blood picture following injection of turpentine do not occur. Following local exposure the oxidase is increased, while following total body exposure to 600 r it is definitely decreased. No systemic effect of the exposure could be seen following local treatment. After total body exposure the animals appear rather weak for two or three days, do not eat, and lose weight. All ten dogs were alive and well ten weeks after the exposures.

ERNST A. POHLE, M.D., Ph.D.

BONE DISEASES (DIAGNOSIS)

Ankylosing Spondylitis and Polyarthritides (Bechterew, Strümpell-Marie, and Related Types). E. Walter Hall. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1933, 30, 608-614.

Emphasis is given to the belief that all forms of multiple spondylarthritides are manifestations of a systemic disease, with trauma, occupational posture, strain, and pre-existing local infection varying in importance in individual cases. The Bechterew, or hypertrophic, type of spondylarthritides (slowly developing type) is considered the result of an underlying hereditary tendency, with trauma as the exciting cause, while the Strümpell-Marie or atrophic type (rapidly progressing form) is probably of toxic or disturbed nutrition origin. In each type there is more or less demineralization of the bones while calcium is laid down in the soft tissues, particularly the paraspinal ligaments. The Bechterew type progresses slowly and the patient is not incapacitated, hence strain and mobility are continued as a result of which, together with well recognized hypotonicity of the back muscles, there is kyphotic bowing of the dorsal segment and pressure atrophy of intervertebral discs, with osteophyte formation beginning at the anterior margins of the vertebral bodies. These two effects of muscle hypotonicity and calcium metastasis may be related to parathyroidism. In the Marie-Strümpell type, being rapidly progressive, there is insufficient time for spinal deformity before ligamentous calcification produces immobilization of the spine. The possibility of toxins acting as a stimulant of the parathyroids to over-activity is suggested, particularly in the Marie-Strümpell type of involvement.

It has been found that in some cases of ankylosing polyarthritides, with muscular hypotonus, stiffness, and pain, parathyroidectomy has given early relief of pain and stopped progress of the calcium metastases.

J. E. HABBE, M.D.

Morquio's Disease: Report of Two Cases. David B. Davis and Fred. P. Currier. *Jour. Am. Med. Assn.*, June 30, 1934, 102, 2173-2176.

The authors report two cases and review the literature on the subject. Morquio, of Montevideo, in 1929, reported a peculiar form of familial osseous dystrophy, occurring in four children of five of the same family. The children developed normally during the first year; the bony changes appeared about the time they commenced to walk, "sparing only the head and face and causing no pain or other suffering, but functional troubles affecting especially motility and physical trouble destroying the harmony of the body." The deformities are symmetrical, the extremities are of normal length, though deformed, and the thorax is "reduced in length and broadened."

Roentgenograms showed delayed epiphyseal development and distortion of the shaft of the phalanges, metacarpals, and metaphyseal ends of the bones of the arm and forearm. The phalanges were thickened and their trabeculae were irregular and distorted. There were

irregular areas of decreased density near the metaphyses. The cranial vault was large, with a thin wall, and showed no increase in digital markings. The anterior wall of the sella was imperfectly developed. The bridge of the nose was sunken. The head was scaphocephalic; the jaw bone was larger than normal and out of proportion to the skull. The anteroposterior diameter of the chest was increased. The spine was straight, showing a lack of normal curvature and presented areas of exuberance.

Morquio stated that the face and head were not involved; Meyer and Brennemann noted that the head was large; Ruggles stated that the head was large, "eyes wide spaced and the root of the nose depressed." Optic atrophy, with resulting blindness, is usually seen in the later stages.

Morquio is the only writer who noted marked abnormality in the blood chemistry. He believed the disturbance of osteogenesis could be explained by the low calcium content of the blood.

The condition has some of the characteristics of achondroplasia, but there are certain changes that cannot be explained entirely on this basis.

CHARLES G. SUTHERLAND, M.D.

Osteopoikilosis. Leslie F. Wilcox. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1933, 30, 615-617.

This condition is a hereditary anomaly developing from a congenital cartilage anlage, and should be grouped with the dyschondroplasias. The author's two cases occurred in father and son, the latter being 21 years old at the time of the roentgen study. No cases reported in the literature had any symptoms which were referable to the bone changes. Similarly the blood calcium and blood phosphorus have always been found to be normal. Three types of this anomaly of bone development are described as follows: (1) the spotted (common) form; (2) the striated (rare) form, and (3) the combined forms. In all cases the areas of bone condensation which vary from two millimeters in diameter to several centimeters in length are always found in the epiphyses and metaphyses, never in the mid-portions of the diaphyses. They follow a longitudinal arrangement. The skull bones are never involved.

J. E. HABBE, M.D.

Marble Bones. A. Howard Pirie. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1933, 30, 618-620.

Marble bones is a rare condition characterized by the transformation of the spongy parts of the bone into solid compact tissue. In the early stage, the carpal and tarsal bones, vertebrae, and iliac bones show marginal bands of increased density. Osteoporosis is the antecedent stage to the sclerosis of marble bones. Pathologic (true transverse, non-comminuted) fractures are common, but healing by adequate callus occurs promptly. Chemical analysis of the bone shows only

about 1 per cent increase in calcium and a slighter increase in phosphorus, although the phosphorus content of the blood is more frankly increased. Consanguinity seems to play an important part in the occurrence of the disease.

J. E. HABBE, M.D.

Parathyroidism—Its Clinical Symptomatology. Max Ballin. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1933, **30**, 571-577.

According to the author the time has arrived to discontinue presenting such conditions as giant-cell tumor, bone cyst, and osteitis fibrosa cystica as separate entities; they should rather all be considered under the single term "parathyroidism." The use of the single term "parathyroidism" will lead not only to a better understanding of etiology but also of the proper treatment.

It should, of course, be understood that other endocrine disturbances cause skeletal changes recognizable roentgenologically, as, for example, thyroidism causing disturbances in calcium deposition and certain forms of arthritis, pituitarism (basophil adenoma of pituitary) with skeletal changes at times, xanthomatosis, a disturbance of lipid metabolism, and certain splenic disorders in children with skeletal changes.

It is a well established fact that when the parathyroids are irritated by hyperplasia or by an adenoma, a hypercalcemia occurs, calcium being removed from the skeleton. It has also been shown repeatedly that the removal of the adenomatous parathyroid effects a cure of the skeletal disturbance.

The hereditary factor is considered important in explaining the occurrence of parathyroidism. Diet may also be a factor in contributing both to the development and control of this condition. In a group of 10 cases on record the onset followed early surgical menopause.

Concerning symptoms, the pain usually begins in the hips and radiates down the legs, later being experienced in other bones. In older individuals bowing deformities are not uncommon, and there is a rather marked muscular weakness.

An important pathologic change, often recognizable roentgenologically, is in the nature of secondary calcium deposits from the overloaded blood stream along the vertebral ligaments, in the intervertebral discs, in blood vessel walls, and usually visible microscopically only in the liver, spleen, intestinal mucosa, and kidneys.

Entirely negative roentgen findings (and gross appearances of the bones at postmortem) may occasionally be encountered, yet microscopically widespread skeletal changes are present. Similarly only a single bone may show roentgenologically a decalcification, as, for example, the so-called monostotic Page's, yet pathologically the changes are extensive. Laboratory findings of hypercalcemia and hypophosphatemia may occasionally be absent temporarily.

The real case of parathyroidism in contrast to the temporary parathyroid disturbances of late rickets,

osteomalacia, or vitamin insufficiencies, does not respond to ultra-violet rays, vitamin feeding, or calcium and parathyroid administration. In fact, the true cases are made worse. Radiation treatment in hyperplastic cases is rational but not always effective. Surgical removal of the adenoma or of hyperplastic tissue is often lifesaving and may return the patient to normal. Recalcification after operation has been observed as early as the sixth week; bone cysts and giant-cell tumors solidify, and bone pain is promptly relieved.

J. E. HABBE, M.D.

Osteomalacia: A Brief Review of the Modern Conception of the Disease. Paul C. Hodges and Alfred C. Ledoux. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1933, **30**, 590-595.

Osteomalacia is primarily a disease manifestation of Vitamin D deficiency, yet it may be considered to be the manifestation of rickets in the adult. It is a disease rarely encountered in this country (observed most often in pregnant or lactating women), but is said to be common in India and China where ignorance and religious custom require women to be confined to dark quarters on an inadequate diet.

Clinically, there is pelvic pain ranging from mild to intense; gait may be waddling or entirely impossible; calcium and phosphorus content of the blood is usually disturbed; roentgen examination reveals alteration in the appearance of the spine, pelvis, femora, and sometimes other long bones. The cortex of the bone is paper-thin; the trabeculae appear as a faint network; multiple fractures of the pelvic bones are common. The treatment is plenty of sunshine and an adequate diet, particularly full in Vitamin D.

J. E. HABBE, M.D.

CALCULI

Sialolithiasis. Paul W. Greeley. *Jour. Am. Med. Assn.*, June 23, 1934, **102**, 2078-2081.

Harrison found 375 reported cases in the literature from 1825 to 1926 and added 27 of his own. The stones are usually single, but one author reported the removal of fourteen from one gland and its duct. Stones weighing as much as 236 gm. have been reported, while this particular calculus measured $1\frac{3}{4}$ by 1 by $\frac{1}{2}$ inch. These concretions may vary from the size of a millet seed to that of a walnut. One case was reported in an infant less than one month old. The calculi are more common in males than in females. In about 75 per cent of all cases the stones were in the submaxillary ducts or glands, about 20 per cent in the parotid, and a small number in the sublingual duct or glands. Badanes believes that three principal substances contribute to their formation, namely, calcium oxalate, globulin, and mucin. Calcium carbonate and phosphate stones are sometimes formed around a foreign body nucleus.

Hamlin believes that negative roentgenographic findings are often the result of faulty technic. A calculus in the anterior two-thirds of Wharton's duct can readily be demonstrated by using a $2\frac{1}{2}$ by $3\frac{1}{2}$ inch film, placed horizontally between the teeth as far back in the mouth as possible, and by directing the rays from beneath the chin upward. A calculus in the posterior third of the gland itself will be best shown by taking a lateral view. The anterior two-thirds of the duct cannot be demonstrated by a lateral film because the duct will be obscured by the shadow of the mandible. Those in Stenson's duct can usually be shown on a small film held over the outside of the duct and parotid gland on the cheek.

The differential diagnosis is discussed in detail. Salivary calculi may recur; recurrences after operative removal are noted most frequently in the submaxillary and sublingual glands and ducts. The period between operative removal and recurrence has been noted to vary from a few months to five years. A recurrent attack may be due to: (1) failure to recognize concretions of the excretory ducts of the salivary glands at operation, during which these are often forced into the ducts; (2) breaking of the calculus during removal, and (3) transitory or permanent cicatrization of the salivary passages after removal of a stone without simultaneous extirpation of the gland. The universal pre-operative use of roentgenography should localize and identify these calculi accurately so that all can be removed at operation. Treatment may be medical or surgical or a combination of the two.

CHARLES G. SUTHERLAND, M.D.

CHEST ROENTGENOGRAPHY

The Interpretation of the Triangular Basal Shadows in Roentgenograms of the Chest. G. E. Richards. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1933, **30**, 289-295.

The term "triangular basal shadow" is used by the author to designate an abnormal density occurring in either side of the lower chest, which renders obtuse the cardio-diaphragmatic angle, its lateral border being straight or slightly curved. On the left side it may be more or less obscured by the heart shadow. This shadow has been observed by the author in 10 instances out of 2,000 consecutive routine chest examinations and is attributed to an atelectatic lower lobe, a phase of bronchiectasis. By intratracheal injection of lipiodol into the side of the chest showing the triangular density, one may regularly demonstrate the bronchiectatic cavities. A whole lower lobe may be represented by the triangular shadow, the atelectasis being associated with rather marked downward rotation of the involved bronchi. However, according to others who have investigated the same subject it is probable that most of these cases occur in individuals presenting anomalous development of the lungs in the form of an accessory inferior lobe, the pathology then being limited to the accessory lobe.

J. E. HABBE, M.D.

CONTRAST MEDIA

A Contribution to Brain Arteriography. Otto Dyes. *Röntgenpraxis*, February, 1934, **6**, 93-95.

The demonstration of pathologic changes of the vessels of the brain by the injection of contrast media is not only of value in diseases which lead secondarily to their displacement, but is important also in diseases of the arteries themselves. In the author's case a small piece of a gunshell was found in the region of the second cervical vertebra. The patient complained of weakness in the right arm, disturbance of vision, and attacks of aphasia. An arteriogram produced by the injection of thorotrast in the left internal carotid showed an aneurysm in the proximity of the foreign body; the anterior cerebral artery could not be visualized, apparently because of embolic occlusion. An encephalogram showed atrophy of the brain and some enlargement of the anterior left ventricle. The roentgenologic examination was of great help in establishing the connection between the foreign body and the neurological symptoms.

HANS W. HEFKE, M.D.

THE ESOPHAGUS (DIAGNOSIS)

The Congenitally Short Esophagus. Louis H. Clerf and Willis F. Manges. *Jour. Am. Med. Assn.*, June 16, 1934, **102**, 2008-2012.

Atresia of the esophagus with an esophagotracheal fistula has long been considered the most common congenital anomaly of this structure. Congenital stenosis is more common than personal records or reports in the literature by esophagoscopists would indicate. It may not produce symptoms until solid food is eaten; in some cases, symptoms of obstruction may not occur until adult life has been reached. The scarcity of reports of these cases in the literature should not indicate that the condition is rare. The authors have seen 14 cases within four years; all other data pertaining to this anomaly have appeared in the British medical literature.

No classic symptom group has been suggested. One can divide the cases into two groups. In one, the outstanding symptoms are dysphagia and regurgitation, with disturbances in nutrition and growth. In the other group, distress, particularly after eating, has been noted in addition to dysphagia, with lodgment of food and regurgitation. Certain cases are symptom-free until dietetic indiscretions result in the lodgment of food or the development of pathologic lesions direct attention to the esophagus. Careful investigation will often reveal that dysphagia has been present since birth or, more commonly, since solid food has been added to the dietary.

Weight loss was particularly noticeable in the children, all of whom were underweight and poorly developed. Symptoms varying from "indigestion" and flatulence to severe epigastric pain were present in seven adults and one child. These occurred shortly after taking food. Severe pain was a prominent symptom in four.

The essential points in the roentgen diagnosis of congenital shortening of the esophagus are: First, a portion of the cardiac end of the stomach must be shown to stay above the level of the diaphragm; second, the esophagus must be shown to be too short to reach as low as the level of the diaphragm.

CHARLES G. SUTHERLAND, M.D.

Diagnosis and Therapy of Pedunculated Esophageal Tumors. Chichio Jamiya and Schuei Nosaki. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, **49**, 481-498.

A detailed report of a fibroma of the esophagus of considerable size, diagnosed roentgenologically and esophagoscopically as a benign tumor. It was removed through the esophagoscope in several stages. A review of the literature is appended, and differential diagnosis.

H. A. JARRE, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Role of the Gastro-intestinal Tract in Conditioning Deficiency Disease: The Significance of Digestion and Absorption in Pernicious Anemia, Pellagra, and "Alcoholic" and Other Forms of Polyneuritis. Maurice B. Strauss. *Jour. Am. Med. Assn.*, July 7, 1934, **103**, 1-4.

A new concept is that deficiency disease in man may and frequently does develop because of some disturbance of the gastro-intestinal tract in spite of an apparently adequate diet. Castle, in 1928, demonstrated clearly that an asymptomatic abnormality of gastric secretion might condition a state of dietary deficiency irrespective of the adequacy of the diet. Pernicious anemia, pellagra, alcoholic and pregnancy polyneuritis, idiopathic hypochromic anemia, and the "toxemias" associated with intestinal obstruction and vomiting in pregnancy, among other conditions, may be due in many instances wholly or in part to deficiencies resulting from disturbances of the gastro-intestinal tract.

CHARLES G. SUTHERLAND, M.D.

The Incidence of Malignancy in Chronic Pre-pyloric Gastric Ulcerations. Aubrey O. Hampton. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1933, **30**, 473-479.

It is well known that the benign or malignant nature of certain gastric ulcerations cannot be determined by cross examination. However, the localization of such a gastric lesion as determined roentgenologically may offer considerable aid. Proven cases of benign gastric ulcer were grouped as to location in the following way: pyloric; pre-pyloric (one inch of the stomach immediately proximal to but not including the pyloric canal), near pylorus, and media. Proven cases of gastric cancers were grouped according to location, as follows: pyloric end; media; cardia, or diffuse. It was noted that the incidence of occurrence of malignant lesions

to benign chronic (indurated) ulcers in the pre-pyloric segment was as 12 is to 1. In those relatively infrequent cases diagnosed clinically and roentgenologically as benign pre-pyloric ulcer, a follow-up of eight cases showed all returning within an average time of two years as advanced carcinomas of the stomach. Hence it is the conclusion of the author that all lesions presenting the appearance of chronic pre-pyloric ulcerations should be treated as malignant.

J. E. HABBE, M.D.

Chronic Disturbances of Motility in the Duodenum. Zoltan v. Alföldy. *Röntgenpraxis*, May, 1934, **6**, 282-287.

Chronic duodenal stenosis and megaduodenum should be differentiated. In megaduodenum, other constitutional anomalies are present, as megalocolon, an abnormally wide jejunum, an abnormal position of the duodenal-jejunal junction and others. In the cases of duodenal stenosis there must be a mechanical cause for the complete or partial obstruction. The roentgen signs of a stenosis are, according to Holzknecht: dilatation of the duodenum, stenotic peristalsis, and a duodenal residue after six hours. There have been some cases of duodenal stenosis described during the last few years, in which no anatomical explanation could be found at operation. The nervous system might be responsible for this symptom-complex in some of these cases.

The author's patient, a woman complaining of indigestion and nausea, had an enormously dilated duodenum at the roentgenologic examination, especially in the descending and horizontal portions. The peristalsis was hyperactive: eight hours after the barium meal there was still some barium in the duodenum, while the stomach was empty. At operation the dilatation was very evident, but no adequate reason for obstruction could be found. A posterior gastroenterostomy was done, which did not function well for two weeks because of a vicious circle. It is the author's belief that fine adhesions between the duodenum and the gall bladder, found at operation, might have led to a reflex stenosis in the neuropathic patient.

HANS W. HEFKE, M.D.

HEART AND VASCULAR SYSTEM

Kymographic Analysis of the Movements of the Heart. P. Stumpf. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1934, **49**, 211-224.

Analysis of planikymograms of the heart, refined by densography, is hardly inferior to other polygraphic diagnostic curves of the circulatory system.

Investigation of the movements of various cardiac segments in relation to those of the aorta led to these conclusions:

(1) Medial excursion of the left ventricle does not necessarily coincide with the whole period of systole; its start fluctuates widely. During systole marked medial excursions are noted quite regularly, but their

start and termination may show pronounced lag in various ventricular segments.

(2) Movements in the region of the left auricular appendix are quite variable though usually two peaks and two troughs are recognized.

(3) Three components are usually observed in the movements of the right cardiac border; their influence at different levels fluctuates widely, so that at times excursions in opposing direction may be found simultaneously in cranial as compared to caudal segments. The old problem as to the margin-forming part of the right cardiac border cannot be solved by most detailed analysis.

Transitions of excursions along the cardiac borders take place quite gradually, so that one may recognize in adjacent segments influences of different efforts.

In the first oblique diameter it was possible to demonstrate different movements of the anterior and posterior aortic wall, because dilatation and change in position produce additive effects along the anterior and lateral margins, subtractive effects on the posterior margin at certain phases; thus the movements may appear disrupted. With increasing frequency of pulsations there occurs no reduction of the duration of the contraction during the expulsive phase. Duration and amplitude of excursions of the left cardiac margin cannot be used for evaluation of cardiac competency and sufficiency; they may be used though for recognition of the distribution of the movements, which observation might be more adaptable to pathologic and anatomic viewpoints. Kymography is an excellent addition to electrocardiography, but never will replace it and should not be compared to it.

HANS A. JARRE, M.D.

Calcification in Aortic and Mitral Valves, with a Report of 23 Cases Demonstrated *in vivo* by the Roentgen Ray. Merrill C. Sosman and Paul H. Wosika. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1933, **30**, 328-348.

When there is marked calcification in the heart valves it should be rather easily possible for anyone experienced in roentgenoscopy to visualize the same, if he understands where and how to look for it. To show even advanced calcification convincingly by means of roentgen examination requires special methods, using high power equipment and rapid exposure technic (1/20 second or faster). The authors' first case found roentgenoscopically was reported in 1924. The first case of aortic stenosis with calcification, recognized *in vivo*, to be reported in the literature was by Christian in 1931. Pericardial calcification had first been demonstrated *in vivo* and reported by Klason in 1922.

Concerning aortic calcification in the 12 cases (9 males and 3 females) reported by the authors, the average age was 53 years; half gave a history of preceding rheumatic fever; two-thirds were aware of heart trouble, seven being hospital patients, 10 with a

systolic basal thrill, and 11 with a harsh systolic basal murmur, 11 showed cardiac enlargement, and all but one showed calcification roentgenologically.

In the mitral group, comprising 13 cases (8 males and 5 females), half gave a previous history of rheumatic fever (11 to 36 years prior to discovery of calcification). All but one were aware of the presence of heart disease (7 patients were fibrillating, a diastolic and systolic murmur was heard at the apex in the nine youngest, cardiac enlargement was present in 12, the blood pressure in general was low, and calcification of the mitral valve was demonstrated roentgenologically in all cases).

In these cases syphilis did not seem to be a factor in causing the calcification, whereas past rheumatic fever was looked upon as an important factor, although the Mönckeberg theory is against the inflammation theory and in favor of degeneration of the media of the aortic wall with extension of calcification to the valve walls.

Concerning roentgenoscopic visualization, adequate preparation of the eyes and the use of a small diaphragm opening are emphasized, the patient being rotated 15 to 20 degrees to the left of the usual postero-anterior position. A dancing movement toward the apex with each systole is observed and this motion is best noted at held inspiration. Most calcified aortic valves are located at the left border of the spine in the anteroposterior view and about midway or just behind the center of the heart substance, whereas calcified mitral valves lie well to the left of the spine and are in the posterior third of the heart.

The most confusing shadows are cast by calcification in the costal cartilages or by calcified glands.

Condensed clinical histories of all cases reported are included in the article.

J. E. HABBE, M.D.

Multiple Aneurysms of the Smaller Branches of the Pulmonary Artery. John M. Barnes and Daniel E. Stedem. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1933, **30**, 443-448.

Aneurysms of the pulmonary artery (excluding small vascular dilatations secondary to pulmonary cavitation) are relatively rare, and of these the great majority, 85 per cent, involve the main trunk and most of the remainder the larger branches. Aneurysms of the terminal branches may be the result of mycotic infection or on the basis of congenital defects.

The case reported here was that of a female aged 50 years, who was first seen because of repeated severe epistaxis, which began at the age of 39 years. Shortly prior to admission to the hospital she had developed nausea, with occasional vomiting and blood in the stools. On admission, the physical findings were those of marked anemia and small bilateral pleural effusion. X-ray study of the chest showed rounded shadows in the right upper lung, interpreted as probable pulmonary metastases, and effusion at both bases.

The patient died of coronary thrombosis a few days after admission and showed at necropsy a large ac-

accumulation of blood under pressure in the left pleural cavity. In the left lower lung a mass of clotted blood was found lying in a sac formerly adherent to the diaphragm but with a rent in its side through which the bleeding had undoubtedly occurred. This sac was continuous with a branch of the left pulmonary artery. In the right chest there was no blood but there was found in the upper lung several small pulmonary artery aneurysms, each about 2 cm. in diameter.

In reviewing the films after the postmortem findings had been obtained, the authors observed that the nodular shadows in the right upper lung showed a definite vascular connection with the hilus, and on this basis plus the possible demonstration of pulsation of the densities fluoroscopically, conclude that in the future a correct differential diagnosis may be possible.

J. E. HABBE, M.D.

HYPERPARATHYROIDISM

The Differential Diagnosis of Hyperparathyroidism. Alexander B. Gutman, Paul C. Swenson, and W. Barclay Parsons. *Jour. Am. Med. Assn.*, July 14, 1934, 103, 87-94.

Four new proved cases are presented. The data in 115 other proved cases in the literature were analyzed to indicate the incidence of initial presenting symptoms and their relative diagnostic significance. The disease occurs more frequently in females (86 females and 29 males) and most frequently in middle life. The course of the disease is usually measured in years, rarely in months. The disease begins most frequently with pain, usually a dull ache in the lower part of the back, legs, or arms, intensified by exercise and often associated with stiffness of the joints. The pain tends to become more diffuse and intense. Bone tenderness, localized at first, is common and may eventually become generalized. Muscle weakness with hypotonia may be so marked as to simulate Addison's disease, myasthenia gravis, or progressive muscle dystrophy, when associated with muscle wasting. Localized bone swellings, solitary and painless at first but multiple and tender later on, are most common in the jaws but occur frequently in the tibia, phalanges or elsewhere, particularly after slight trauma. They may appear years before the general symptoms and may be difficult to differentiate pathologically from sarcoma or from focal osteitis fibrosa. Pathologic fractures increase in incidence as decalcification progresses—turning in bed or coughing may result in fracture. Non-union and mal-union are common. Deformities of all types occur, sometimes with loss of height and bizarre mutilation of the extremities. Disturbances of gait of the waddling type, or limp, may develop relatively early and become progressively worse.

Polyuria and polydipsia may be so marked as to suggest diabetes insipidus. Renal colic was the predominating symptom in about 10 per cent of the cases. Episodes of intractable nausea and vomiting may appear suddenly and persist for weeks or months. Anorexia and stubborn constipation are common and may

be presenting symptoms. In six cases, sharp pain in the abdomen appeared. The gastro-intestinal symptoms may so dominate the picture as to suggest duodenal ulcer or acute appendicitis. Weight loss was a major complaint in one-fourth of the cases. Moderate secondary anemia was common. Nervousness, tachycardia and other symptoms have been described. A tumor in the neck could be palpated definitely in less than 10 per cent of the cases.

The outstanding roentgenologic feature is general decalcification of the skeleton, a finely granular appearance of the skull with thickened bone and indistinct tables. In the long bones, thinning of the cortex and the trabeculae, with indistinct, irregular, and fuzzy outlines. Cyst formation may be present in the central portion of the shafts or subperiosteally. The vertebrae show a granular pattern much like the calvarium with an added coarsely striated appearance. The terminal phalanges are often almost completely resorbed. The mineral metabolism is discussed in detail.

CHARLES G. SUTHERLAND, M.D.

THE KNEE JOINT

Relationship between Anatomic Changes in Knee Joint with Advancing Age and Degenerative Arthritis. C. S. Keefer, F. Parker, Jr., W. K. Myers, and R. L. Irwin. *Archiv. Int. Med.*, March, 1934, 53, 325-343.

In a study of 100 knee joints from 77 consecutive patients who died of various diseases, the following facts were determined:

1. Anatomic changes were noted with increasing frequency with advancing age.

2. The patella showed alterations in 81 per cent of the cases, the interpatellar groove in 65 per cent, the lateral condyle of the tibia in 64 per cent, the medial condyle of the tibia in 55 per cent, the medial condyle of the femur in 43 per cent, and the lateral condyle in 36 per cent.

3. The erosions were commonest over the areas of contact which were subjected to the greatest movement, strain, weight-bearing, and injury.

4. The changes were identical in males and females, and there was no relationship between the extent of the lesions in the joints and the symptoms referable to the joints.

5. There was no correlation between the lesions in the joints and the degree of arteriosclerosis or any other particular type of disease process.

6. The gross anatomic changes were indistinguishable from those previously described in degenerative arthritis.

7. The various factors which are of importance in the development of degenerative arthritis are discussed. They include the aging of tissue, wear and tear, strain, trauma, occupational and static deformities.

It seems difficult to escape the conclusion that the changes which are seen in the joints with increasing frequency with advancing age are identical with those which have been previously described as characteristic of degenerative arthritis. If this is true, there is justi-

fication for the belief that degenerative arthritis is a process associated with the aging of the tissues of the joints. This conception is essential for a complete understanding of the pathogenesis of this disorder. Added to the process of involution, such factors as gross trauma, hemorrhage, and static deformities exaggerate the condition. The end-result depends on the summation of these factors.

H. A. JARRE, M.D.

THE LARYNX

Importance of the Roentgen Examination in Polypoid Tumors of the Larynx. W. H. McGehee. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1933, **30**, 464-467.

Five cases of polypoid tumors of the larynx, all arising from the anterior wall near the anterior commissure, have been observed by the writer. Four were benign (ages of patients 5, 6, 15, and 19 years) and one was malignant (age of patient, 60 years). X-ray study is particularly helpful in small children and in unco-operative adults, cases in which laryngoscopic study may be unsatisfactory. One may occasionally obtain information by an x-ray study which is not obtainable by laryngoscopy, even with the full co-operation of the patient.

J. E. HABBE, M.D.

THE LIVER

Iodipin-embolism of the Liver. Walter Steffens. *Röntgenpraxis*, February, 1934, **6**, 104-106.

The use of iodized oils for roentgenologic examinations is not always harmless. Harmful effects of these oils, when used for injection of fistulas, for demonstration of the urethra or uterus and tubes, have been reported. The case of a young man is described who had long suffered from a persistent fistula in the left lower anterior thoracic wall, following a gunshot wound. Injection of iodipin into the fistula led to a collapse of the patient and an embolic filling of the vessels of the liver, visible on roentgenograms. The patient recovered in a few hours. Two months later the iodized oil was still visible in roentgenograms of the liver; after sixteen months only traces could be seen. It seemed reasonable to explain this accident by the entrance of the contrast material into a vein around the fistula and close to the foreign body, from whence it was transported to the liver through the portal vein.

HANS W. HEFKE, M.D.

THE LUNGS

Significance of Roentgenologic Changes in Differential Diagnosis of Atelectasis. Willis F. Manges and John T. Farrell, Jr. *Am. Jour. Roentgenol. and Rad. Ther.*, October 1933, **30**, 429-442.

Atelectasis is of two varieties, acquired and congenital, the latter type being relatively uncommon; some cases, occurring in newborns and therefore being classi-

fied as congenital, may actually be acquired at birth by inhalation of foreign material. The acquired form occurs more often in adults than in children and is seen more often in males than in females. The causes are as follows: inhalation of a foreign body (usually organic matter, such as a navy bean); post-operative collapse; bronchial tumor; tuberculosis; pneumonia; asthma (all intrabronchial sources); enlarged tracheo-bronchial nodes; mediastinal tumor; aneurysm (extrabronchial sources). Characteristic roentgenologic findings are as follows: increased density of atelectatic area due to absence of air and vascular engorgement; elevation of diaphragm and retraction of mediastinal contents toward the affected side. If air can neither get in nor out, the action may be described as of a "stop-valve" nature, whereas if air can get in but not out, the obstruction may be called "check-valve," the latter type producing at least temporarily an obstructive emphysema.

Unlike the atelectasis of bronchial tumor or long-retained foreign body, massive post-operative collapse usually subsides spontaneously and without the sequelae of drowned lung, chronic atelectasis, extensive bronchiectasis, or abscess. The explanation is that in the post-operative type there is a disturbance of the bronchial secretory function to which the lung adjusts itself; whereas in the other types there is no regulation of the secretory mechanism, thus drowned lung and infective changes commonly follow unless the collapse is quickly relieved.

Atelectasis in tuberculosis is probably much more common than is diagnosed, but is apt to involve only small scattered areas of lung, such changes not being readily recognizable in the presence of pleuro-pulmonary infiltrations. In asthmatics, atelectasis may occasionally occur and be responsible for attacks of sudden dyspnea, the basis for the collapse probably being bronchial plugging with mucus.

Abscess of purely inflammatory origin is rarely associated with signs of atelectasis, whereas abscess secondary to bronchial or pulmonary tumors is often associated with x-ray evidence of pulmonary collapse.

J. E. HABBE, M.D.

MUCOUS COLITIS

So-called Mucous Colitis. London Letter. *Jour. Am. Med. Assn.*, June 9, 1934, **102**, 1951, 1952.

In a discussion at the Royal Society of Medicine, Dr. A. F. Hurst showed the term was misleading and that specialism in therapeutics had dangers even greater than those in other branches of medicine. An expert in any line of treatment was tempted to accept the diagnosis already made in cases sent to him and to apply treatment without sufficiently full consideration. Fuller investigation might show that the so-called mucous colitis was the result of achlorhydria and could be rapidly cured by gastric lavage or administration of hydrochloric acid; or that it might be the first manifestation of carcinoma of the pelvic colon. He considered there was no such thing as mucous colitis.

Mucous colitis meant inflammation of the colon associated with the passage of excess of mucus. It was necessary to consider in what conditions an excess of mucus was passed. The secretion was increased in response to mechanical and chemical irritants. Hard feces in the pelvic colon and rectum acted as mechanical irritants. The most common chemical irritants of the colon are purgatives; they produced an excess of mucus, but again no inflammatory products. The use of irritating suppositories, enemas, and douches always called forth an abundant secretion of mucus. Lastly, when excess of undigested food reached the colon, as in achlorhydric gastritis and in enteritis, the colonic mucous membrane might respond by secreting mucous, although no colitis was present.

Cases of mucous colitis, in which liquid stools containing excess of mucous and of leukocytes, with sometimes a few red blood corpuscles, were known in which the sigmoidoscope revealed inflammation. In mucomembraneous colitis, the membrane was formed of coagulated mucus and did not contain inflammatory material. The condition should be called mucomembranous colic; it depended on abnormal irritability of the sympathetic nerve supply of the colon and was occasionally allergic, the mucous casts representing the Curschmann spirals of asthmatic patients.

He had found diathermy of the utmost value in the treatment of the frequent functional disorders of the intestine that result from abnormalities of the anal canal. Auto-intoxication resulting from stasis in the colon he regarded as a myth. Untreated constipation is rarely the cause of toxemia.

CHARLES G. SUTHERLAND, M.D.

THE PELVIS

The Differential Diagnosis of Phleboliths and Ureteral Calculi in Roentgenograms of the Small Pelvis. O. Buetzler. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, 49, 253-262.

Sixty-seven male and forty-three female pelvises were reviewed for phleboliths—the former contained 254, the latter 196. They are not scattered throughout the pelvis, as is often assumed, but are concentrated in the lower pelvic segments, distributed over a wider area in female pelvises, where many are located in the broad ligaments. Ureteral calculi are never located in an area of fingerbreadth width, following the linea terminalis. In male pelvises, phleboliths are not encountered two fingerwidths below the sacro-iliac articulations; in female pelvises, they are found in such a location in only 1 per cent of all cases.

Excretion pyelography with stereo-films is recommended for localization.

H. A. JARRE, M.D.

PEPTIC ULCER

The Diagnosis of Peptic Ulcer of the Esophagus. Gottfried Pesek. *Röntgenpraxis*, February, 1934, 6, 99-102.

Roentgenologic demonstration of peptic ulcer of the esophagus has been reported only twice, as far as the author could find. In his case the roentgenologic diagnosis was confirmed at autopsy. In 1928 the patient had complained of difficulty and pain on swallowing. Roentgen examination and examination with the esophagoscope did not show any evidence of ulcer at that time, but, rather, the picture of a cardiospasm. The symptoms persisted and in 1933, at a re-examination, the roentgenologic diagnosis of an ulcer in a stenotic area of the esophagus just above the cardia was made. The niche and the stellate arrangement of the mucosal folds were typical. The patient died after a gastrotomy, and an autopsy confirmed the diagnosis of a stenosing ulcer in the cardiac portion of the esophagus.

The author believes that ulcers of the esophagus or scars following them are much more frequent than is now believed. He quotes the pathologist Gruber, who reports that the proportion of ulcer or scar in the cardiac portions of the esophagus and gastric ulcer is in the ratio of 1 to 30.

HANS W. HEFKE, M.D.

RADIUM

Radium Therapy of Hemangioma. W. Baensch. *Deutsche med. Wchnschr.*, 1934, 60, 923.

The author describes his technic in the treatment of large, cavernous hemangioma. He advocates the use of platinum radium needles, containing from 1 to 4 mg. radium element. Screened radium in the form of suitable surface applicators is then applied from the outside. Two to four applications are usually required; the total dose in large lesions is about 1,500 mg.-hrs. for children and 4,000 mg.-hrs. for adults. It is important to wait at least from four to six months after the treatment in order to obtain the optimal benefit. Several photographs are appended showing patients with extensive lesions before and after treatment.

ERNST A. POHLE, M.D., Ph.D.

SACRO-ILIAC JOINT

Typical Birth Trauma of the Sacro-iliac Joint. E. Philipp. *Röntgenpraxis*, May, 1934, 6, 291-295.

While traumatic changes of the symphysis pubis are relatively well known, not so are similar changes in the sacro-iliac joints. The author observed several women with pain in the sacro-iliac region after childbirth, which radiated into the legs, and was considered to be due to a sciatic neuritis. Gynecologic examination revealed a very tender swelling in the posterior pelvis in the region of the sacro-iliac joint. On roentgenograms of the pelvis the joint outline was hazy and irregular when compared with the normal side. There was no widening of the joint space.

One deals in such cases with a post-partum traumatic hematoma which must be situated between the bone and the ligaments in front of the joint. Roentgeno-

logic re-examination some weeks afterward showed a normal appearance in all instances. Arthritic processes might have their beginning in these traumatic changes.

HANS W. HEFKE, M.D.

SCHÜLLER-CHRISTIAN SYNDROME

The Roentgen Therapy of Schüller-Christian's Disease. R. Stewart-Harrison. *Röntgenpraxis*, May, 1934, 6, 305-307.

Favorable results of roentgen therapy have repeatedly been described in cases of Schüller-Christian's disease. In one of the author's cases the benefit of x-ray treatments was not very convincing. A 24-year-old man had all the signs of this disease: abnormal lipid-metabolism, typical roentgen findings in skull and other bones, and a biopsy characteristic of it. The lungs were apparently also infiltrated by the same process. There was hardly any worthwhile effect of roentgen therapy, which was given in 3 doses, 300 roentgens each, to each focus of disease. It seems possible that some of the remissions reported after irradiation might have been spontaneous. A larger series of cases of this disease treated by roentgen rays is necessary to determine the value of this treatment.

HANS W. HEFKE, M.D.

SILICOSIS

A Comparison of the Development of the Specific Nodule of Silicosis and of Tuberculosis. W. S. Lemon and W. H. Feldman. *Archiv. Int. Med.*, March, 1934, 53, 367-377.

In order to obtain material for a comparative study of the respective morphologic reactions provoked in the lung by particulate silica and by bacilli of tuberculosis, intratracheal injections were given to two series of rabbits. The animals were killed at intervals of from four hours to four weeks after receiving the respective inoculums, and the course and character of the resultant cellular response were studied histologically.

When the organisms of tuberculosis are introduced intratracheally into some animals, and when particles of silica are similarly introduced into others, the reactions leading to production of the specific nodules in both groups are the result of certain factors which the injected substances have in common. Each substance is relatively inert and relatively impervious to injury or destruction by the tissues; each has the ability to become arrested within the lung and thereafter to stimulate hyperplasia of mononuclear cells. In each instance, the lesion is found in regions rich in lymphatic tissue. The resulting specific lesion in each case is preceded by an exudative inflammation, more intense in the case of silica than in that of the organism of tuberculosis.

The ability of the living bacillus to grow and increase in number causes a provocative response which is progressive. The inability of silica to increase in

number of particles and the progressive removal of the initial dosage cause a gradual decrease in the number and size of the lesions.

Phagocytosis of bacilli of tuberculosis by polymorphonuclear cells is much more frequent than phagocytosis of particles of silica. The most actively phagocytic cell in either case is the alveolar phagocyte. Both irritants stimulate hyperplasia of mononuclear cells which ultimately assume an epithelioid appearance, and the nodules formed are constructed of cells of this type. No significant differences could be discovered between the epithelioid cell of the tubercle and the mononuclear phagocyte of the silicotic nodule.

The tuberculous nodule retained its cellular integrity longer than the silicotic nodule; it developed a necrotic center more slowly and much more slowly became invested by collagen. The reticulum of the tuberculous nodule was slower in development and was composed of finer interlacing fibers. The tendency to the development of caseous, massive pneumonia and to a spread by ulceration into adjoining bronchi or blood vessels was much more evident in tuberculosis than in silicosis.

Both types of nodules were avascular and similarly constructed; they had a similar distribution of fat droplets and a similar distribution of bacilli or particles within the nodules.

Both lesions appeared to be the reaction of the reticulo-endothelial system to irritative substances capable of initiating comparable inflammatory phenomena.

The results obtained appear to warrant the following conclusions:

1. The character of the cellular response to the irritative influences of particulate silica and to bacilli of tuberculosis is essentially the same; both promote the formation of characteristic tubercles.

2. The properties of the provocative agent responsible for the production of the silicotic tubercle preclude the formation of a structure characterized by continuous progression. This contrasts markedly with that formed as a consequence of the injection of bacilli of tuberculosis, which is usually of a progressive, destructive nature.

3. *The similarity of the structural unit or tubercle invoked experimentally in response to particles of silica and to bacilli of tuberculosis is so striking as to make their certain differential identification impossible by ordinary morphologic criteria.*

4. Although the pathologic characteristics of the two processes are practically identical during the early period of cellular progression, significant structural differences become evident as the duration of the diseases is extended.

H. A. JARRE, M.D.

THE STOMACH

Further Roentgen-ray Studies of Carcinoma of the Stomach. Maurice Feldman. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1933, 30, 480-487.

The importance of careful consideration of indirect

signs in the detection of organic gastric disease, either malignant or benign, is stressed. Cases in the author's experience, showing definite clinical and laboratory evidence of organic gastric disease but no direct x-ray sign in the nature of a filling defect or niche, have called attention to the importance of the careful study of the indirect findings, of which disturbances in peristalsis, reduction in size, stereotyped shape, and rapid emptying are particularly significant.

The earliest pathologic changes are principally infiltration or induration, with secondary inflammatory reaction. In such cases the roentgenoscopic findings are apt to be entirely normal but, by making a large series of roentgenograms and superimposing films or tracings of them, limited areas of infiltration, fixation, or interference of peristalsis may be shown. Six additional cases are recorded illustrating such changes, all of which had serial roentgen studies over many months' duration and operative or clinical roentgenologic confirmation.

J. E. HABBE, M.D.

THE TRACHEA

Papillomatosis of the Trachea and Main Bronchi. A. Beutel. *Röntgenpraxis*, May, 1934, **6**, 287-290.

A tracheogram and bronchogram of papillomatosis in the upper airways is described and reproduced. The papillomas produced filling defects of different size, which were round or arranged in a bandlike fashion. They projected into the lumen and caused a wavelike boundary of the tracheal shadow. The appearance was that of fairly large esophageal varices. This is the first time to the author's knowledge that these changes have been demonstrated roentgenologically and correctly diagnosed.

HANS W. HEFKE, M.D.

TUBERCULOSIS, PULMONARY

The Importance of the Roentgen Examination in the Modern Treatment of Pulmonary Tuberculosis. B. H. Douglas. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1933, **30**, 305-308.

By means of the x-ray one can diagnose pulmonary tuberculosis both quantitatively and qualitatively. By the term "quantitative" is meant, of course, a minimal, a moderately advanced, or a far advanced lesion. By "qualitatively" is meant an exudative, productive, ulcerative, or combined type of reaction. Cavity formation very frequently defies diagnosis by physical examination without x-ray, and, contrary to widespread opinion, occurs relatively early in the development of many cases; this constitutes further reason for routine immediate x-ray study. In cases which show a positive sputum and x-ray evidence of cavity, when submitted to one or another of the several forms of collapse therapy, the disappearance of the evidence of cavity on the films and the disappearance of bacilli from the sputum constitutes very reassuring evidence that the therapy is proving effective. The author points out that prior to the introduction of x-ray in-

vestigation in chest diagnosis, pneumothorax treatment for pulmonary tuberculosis had been suggested and tried by certain workers, but given up because of inability to successfully estimate the results of this treatment, until close observation of cases by means of the x-ray was popularized, whereupon artificial pneumothorax took its deserved place in the armamentarium of the phthisiotherapist.

J. E. HABBE, M.D.

Roentgenological Manifestations of Allergic Processes in Pulmonary Tuberculosis. Max Pinner. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1933, **30**, 296-299.

According to the author, the exquisitely chronic course of pulmonary tuberculosis is composed of a series of acute phases, which may tend to be immediately regressive although ultimately progressive. Rapid clearing as shown by serial roentgen examination should not be considered evidence against the diagnosis of tuberculosis. The allergic reaction (modified reactivity of the body caused by previous infection) outcome is dependent upon dosage, virulence, time interval, and location. The roentgenologic appearances of allergic reactions are classified into three groups: (a) a focal area, usually 2 to 5 cm. in diameter, located in the periphery of one upper lobe of rather slight density and of blurred margins; (b) a more massive (at times lobar) infiltration resembling non-specific lobar pneumonia, or (c) numerous widely scattered rounded, fluffy shadows, resembling metastatic tumors, or if smaller, pneumoconiosis. At times one sees exacerbations of old foci in the nature of hazy shadows surrounding old fibrotic or calcified areas, at other times one can identify bronchogenic metastases, and still again one may observe terminal bronchopneumonia, spreading into the lower lungs (these last appearances being tuberculous and not non-specific lesions as so often diagnosed).

It is emphasized that without serial roentgenologic studies a vast number of such allergic manifestations will remain undiagnosed and even unsuspected. The prognosis at the onset of each such allergic reaction must be guarded, but on the other hand the possibility of benign outcome (by resorption or fibrosis) should not be underrated.

J. E. HABBE, M.D.

TUBERCULOSIS, RENAL

The Diagnosis of Renal Tuberculosis by Cultures Made from the Urinary Sediment. Daniel N. Eisendrath. *British Jour. Urol.*, March, 1934, **6**, 37-45.

The author finds a close relation between the elimination of tubercle bacilli from a diseased (tuberculous) kidney and the anatomical changes incident to such an infection. For this reason, one may find the bacilli at one examination and not at another. Under certain pathologic conditions there may be few living bacilli or none. When the number of bacilli is very small, one

is more apt to find them by culture methods or by animal inoculation than by staining methods.

In from 15 to 20 per cent of the cases the author was unable to find tubercle bacilli in spite of prolonged search of stained specimens of urinary sediments from patients in whom he suspected or had already made a diagnosis of renal tuberculosis.

In the first series of 57 cases the cultures were positive in 30 cases, whereas the stain was positive in only 20 of the 30 cases. In the second series of 13 cases, the culture was positive in seven, whereas the stain was negative in the five specimens received but had been positive at previous examinations in four of the five cases.

The bladder specimen may be negative, and that taken directly from the kidney be positive; hence it is always advisable to examine the urine obtained by ureteral catheterization.

The inoculation of the guinea pig has many drawbacks. It is the opinion of the author that the culture should always be controlled by animal inoculation to avoid error. The cultures should be kept under observation for at least 90 days. The author found in three of his cases that the cultures were only found positive on the sixtieth and ninetieth days, respectively.

The application of the culture method has been so greatly simplified since 1924 that it should be employed as a routine measure whenever the stain is negative. The culture method is cheaper, more rapid, and more apt to yield positive results than animal inoculation. Compared with staining methods, the culture method is, of course, slower, but will in the future be of inestimable value in the 15 to 20 per cent of cases in which one or more stains are negative and yet one suspects the presence of a renal tuberculosis.

DAVIS H. PARDOLL, M.D.

TUMORS (DIAGNOSIS)

Roentgenologically Circumscribed Tumors of the Alimentary Canal and the Difficulties of Their Differential Diagnostic Interpretation. K. Frick and P. Ott. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, 49, 441-456.

Reviewing their 1,300 examinations of the alimentary canal during 1933, the authors found a number of circumscribed tumors, mostly in the stomach, some in the duodenal bulb and the colon-sigmoid. Neither from the clinical examinations nor from the correlation of these with roentgenologic findings was it possible to determine the character of these tumors with certainty, and the diagnosis had to be left to the pathologist. These tumors represented partly carcinomas, partly myomas, granulomas, pedunculated polyps, chronic inflammatory tumors. Of these, the pedunculated polyp is most amenable to diagnosis. The beautiful detail of mucosal structure demonstrated in the illustrations is well worth seeing. The diagnostic limitations of clinical medicine and roentgenology are shown and the localizing value of correct roentgenologic procedures is emphasized.

H. A. JARRE, M.D.

TUMORS (THERAPY)

Malignant Tumors and Their Treatment by Irradiation. A. Hedfeld. *Strahlentherapie*, 1934, 50, 312-325.

The author gives a brief analysis of the present status of the cancer problem. He states that neoplastic diseases are not only local, but systemic. It seems, therefore, that the treatment of the local manifestation alone will not lead to a permanent cure. Diet and organotherapy are important parts in the treatment. The author also does not believe in the radical operations as practised now and quotes as an example of a less radical procedure carcinoma of the breast. He has used the following method during the last four years: Operable cases are treated first by roentgen rays. If the tumor is reduced in size, the residual growth is removed with the endotherm knife under local anesthesia. Attention is paid to the diet which should be rich. If glands are involved, the tumor of the breast proper is not removed until the glands have completely disappeared. During the last three months he has also been using the organotherapy as developed by Fichera.

ERNST A. POHLE, M.D., Ph.D.

Report Regarding the Experience in Zürich with Protracted Fractional Roentgen Therapy from 1929 to 1932 in Tumors of the Upper Air Passages and Digestive Tract. H. R. Schinz and A. Zuppinger. *Strahlentherapie*, 1934, 50, 237-277.

From April, 1929 to 1932, 184 cases with malignant tumors of the upper air passages and digestive tract were seen in the Roentgen Institute of the University of Zürich. Only 23 of these patients were operable but 6 already showed metastases; 135 cases completed the entire course of treatment. After two years 25.9 per cent were alive and free from symptoms; 22 per cent of the 135 patients are alive for a period of from two to five years. Calculated for the three-year cure period, 18 per cent represented the absolute cure and 23.8 per cent the relative cure.

In tumors of the inner nose and sinuses it is necessary as a rule to use combined surgery and radiation treatment. Tumors of the mouth are usually more resistant than tumors of the pharynx. Sarcoma of the mesopharynx seems to respond well. For that reason the authors used the protracted fractional dose method as the method of choice in this neoplasm. In carcinoma of the tonsil the tumor mass usually shrinks following roentgen therapy; it is often necessary to treat the residual tumor by radium or electrocoagulation. The prognosis for tumors located at the angle between palate and tongue is usually poor. For tumors of the hypopharynx the protracted fractional dose method is to be considered as the method of choice. Tumors in the inner larynx are also usually radiosensitive. No late injuries were seen during the period on which the report is based. Some acute reactions were observed which were due to over-dosage. The authors state that individualization of radiation therapy is essential.

ERNST A. POHLE, M.D., Ph.D.

Telangiectasis and Radiation Therapy. Leopold Freund and Josef G. Knoflach. *Strahlentherapie*, 1934, 50, 326-332.

A woman 58 years of age received x-ray therapy over the right breast following removal of a carcinoma. Three series were given consisting of 800 r each, the radiation filtered through 3 mm. Al. Two months after the last treatment there appeared telangiectasis in the treated area, which looked very similar to that appearing as a late reaction after roentgen and radium treatment. Since the dose had been rather moderate and since no marked erythema had appeared, a biopsy was done in order to determine the nature of the process. Histological studies showed that the telangiectasis was in reality a recurrence of the carcinoma; it appeared in the form of the very rare "erysipelas carcinomatosum." Only 30 cases of this type have been published in the literature. The pathologic process spread and was so extensive that it could not be removed surgically. Intensive radiation therapy brought about relief and at least temporary standstill of the process.

ERNST A. POHLE, M.D., Ph.D.

The Biologic Treatment of Carcinoma and its Relation to Radiation Therapy of Neoplasm. Dr. Fichera. *Strahlentherapie*, 1934, 50, 302-311.

The author reviews briefly his investigations dealing with the organotherapy of malignant tumors. Based on 25 years of research, he recommends the treatment of inoperable, far-advanced, malignant disease with extracts of embryonic tissues, particularly spleen and thymus. In 9 per cent out of 100 patients who were inoperable and radioresistant, the tumors regressed entirely when treated with these extracts, while in 8 per cent there was no further growth or extension. In earlier cases a combination of radiation therapy and organotherapy should prove of value. A few illustrative case histories are appended.

ERNST A. POHLE, M.D., Ph.D.

What Are the Accomplishments of Radiation Therapy in Inoperable Carcinoma of the Cervix? F. G. Dietel. *Strahlentherapie*, 1934, 50, 297-301.

The author compiled 40 groups of statistics from the world literature. His analysis showed that during the period from 1912 to 1928 a total of 7,814 women with inoperable carcinoma of the cervix were treated by irradiation, of whom 882 (or 11.3 per cent) were cured. Thirty of the statistical groups showed that with radium alone the percentage of cure was 9.9 per cent; with x-rays alone 10.5 per cent, and with combined roentgen-radium treatment 13.4 per cent. There seems to be no doubt that the combined therapy shows a marked improvement in the end-results.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Mediastinal and Lung Tumors. René du Mesnil de Rochemont. *Strahlentherapie*, 1934, 50, 290-296.

The author groups tumors of the mediastinum and lungs under three headings. The first group does not lend itself at all to radiation therapy; he mentions lipoma, fibroma, chondroma, teratoma, cysts and changes in the heart, pericardium, and aorta. The second group comprises carcinoma of the bronchus and metastases from other primary foci. Some of these cases may be influenced by irradiation. The third group, tumors of the mediastinum, consists chiefly of involvements in lymph glands, leukemia, Hodgkin's disease as well as lymphosarcoma, which are, as a rule, radiosensitive. In the radiation treatment of mediastinal and lung tumors it is important to avoid systemic reactions as far as possible. The fractional application of the dose is, therefore, the method of choice. It is often necessary to limit the treatment to one field per day. A surface dose of from 200 to 400 r, given over an area of 10×15 sq. cm., is recommended. A total of 18×200 r per field can be administered provided that an irradiation of 1 mm. H.V.L. in Cu is used. The author usually gives 7 to 8 r per minute, so that a single exposure does not exceed from 30 to 50 minutes. The dose effective at the site of the disease may vary from 2,000 to 3,600 r. If patients do not tolerate high doses, it is necessary to reduce the dose per field to 100 r. Most of the 20 cases of lung tumors which the author treated in the past year were so far advanced that one-half of them died within three months after beginning treatment. The remaining half lived about a year, four cases lived two years—among the latter was a carcinoma of the bronchus demonstrated at the autopsy. It is remarkable, however, how much the subjective symptoms can be improved by proper irradiation. In cases with lymphosarcoma of the mediastinum it is necessary to start with moderate doses in order to prevent general intoxication. One of the patients belonging to this group is living nine years after the treatment.

ERNST A. POHLE, M.D., Ph.D.

The So-called Specific Effects of Short Electric Waves in the Treatment of Malignant Disease. M. Haas and Dr. Lob. *Strahlentherapie*, 1934, 50, 345-347.

The author studied the effect of short electric waves (2.8-20 meters) on animal tumors in all stages, namely, beginning with recently implanted neoplasms up to tumors the size of a hen's egg. They could not find any changes in the tumors due to the effect of the electric waves.

ERNST A. POHLE, M.D., Ph.D.

Superior Pulmonary Sulcus Tumor: Further Observations, with Report of Two Additional Cases. Harold W. Jacox. *Jour. Am. Med. Assn.*, July 14, 1934, 103, 84-87.

Evidence is presented supporting the view that superior pulmonary sulcus tumor is an atypical form of primary bronchogenic carcinoma. Opportunity to examine autopsy material from a case of this sort,

characterized by pain, Horner's syndrome, destruction of bone, and atrophy of the hand muscles, convinced the author that the tumor arose from the mucosa of the terminal bronchioles in the apex of the lung. A modification of Coutard's method of intensive deep roentgen therapy failed to control the symptoms of this disease in a second case. Chordotomy should be considered as a valuable palliative procedure.

CHARLES G. SUTHERLAND, M.D.

Roentgen Therapy of Scleroma of the Upper Air Passages. R. K. Kruglikowa. *Strahlentherapie*, 1934, **50**, 333-344.

The author analyzes 172 cases of scleroma which were observed in the Roentgen Institute in Kiev. He recommends 160 K.V., 0.5 mm. Cu + 1 mm. Al, $\frac{1}{4}$ to $\frac{1}{8}$ H.E.D. at intervals of from three to four weeks and later two months. His experience shows that roentgentherapy is apparently the method of choice. Scleroma of the nose is first treated by CO₂ snow and then followed by irradiation. Certain preparations of stibium seem to act as a sensitizing medium and are being used, therefore, in conjunction with roentgen therapy. Tabulations show the distribution of the lesions as to anatomical locations and

the results obtained. A series of illustrations showing patients before and after treatment is also appended.

ERNST A. POHLE, M.D., Ph.D.

ULTRA-VIOLET LIGHT

The Effect of Ultra-violet Rays on the Carbohydrate Metabolism. Paul Kallós and Liselotte Kallós-Defner. *Strahlentherapie*, 1934, **50**, 191, 192.

Rothmann stated that exposure to Finsen light decreases the blood sugar of normal persons as well as those with diabetes. The authors studied this therapeutic possibility on four rabbits. They found that if the animals were kept in a dark room, there was no change in the blood sugar and sugar tolerance. Exposure to the quartz mercury vapor lamp led to a definite reduction in the blood sugar, manifesting itself one hour after the exposure and lasting from six to eight hours provided that no food was given. If a definite skin erythema occurs after the irradiation, the blood sugar drops and at the same time the sugar tolerance is definitely increased. This is still present eight to ten days after the exposure. Based on these experiments the authors have started administering this treatment to diabetic patients.

ERNST A. POHLE, M.D., Ph.D.

strategies